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OUR NATIONAL POLICY AND THE INDUSTRIAL OUTLOOK.

By Cuthbert Mills.

TO review and forecast the industrial situation in the light of the expected sound-money victory in November involves certain preliminary considerations. (1.) Will there be such a victory? (2.) Will the victory be merely an escape from defeat? (3.) Or will the defeat of the Bryan party be complete and overwhelming? It would be rash to predict any one of these events. We hope for the first and the last; but it is plain that, if we get only the second, conditions only slightly improved will continue to confront us. No prudent business man is justified in assuming at this time that he will not be called upon to meet such a state of affairs as would follow from a sound-money victory won only by a scratch. If he adjusts his business to such a contingency, he will be at least safe; and, if the defeat of the silverites be thorough, he will be so much better off. Therefore the part of prudence is to be prepared for a period of difficulty, while assuming that McKinley will be elected; for it is hard to see how all our industrial and financial troubles are to be removed merely by the fact of his election.

We must, anyway, take the chances of Bryan's success. What would be the full consequences of that no man can tell, but for a time there would be something like chaos. It is a risk which we are forced to take, and from which there is no escape. But let us first assume that he *is* defeated; second, to be on the safe side, that McKinley's vote in the electoral college is barely enough to elect him. In such an event the *morale* of the silver party would be but slightly impaired. In the house it would, of course, be powerless. The strength of the

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sound-money party there is not likely to be much less than it was when the Sherman act was repealed. But in the senate, the stronghold of silver, there would be no break in the ranks. The advocates of free silver would be encouraged still further to continue their fight, from the fact that their presidential candidate had come so near to success on this very issue. The result would be a deadlock on all legislation affecting either finances or the tariff.

Such a block could not fail to have a most injurious effect on business. It would not prevent a partial recovery from the state of industrial paralysis from which the country is now suffering, since this comes from an apprehension that the worst may happen,—*viz.*, the election of Bryan; but, on the other hand, it would greatly retard the recovery and probably leave it incomplete. Confidence cannot wholly return, until it is seen that the treasury is safe against the practical exhaustion of its gold reserve.

This is a problem we shall have to face before the next president is inaugurated, whoever he may be. It is full of difficulties, which have been largely increased by the trade conditions brought about by the Chicago convention. One effect of them has been to severely cut down the imports. The immediate consequence of this is beneficial, in that it checks the demand for gold to pay foreign sellers. But on the other side it is bad, because the government revenues are mainly derived from customs duties, and the decrease in imports carries with it a corresponding decrease in the government income, while the expenditures, fixed by law, remain the same. The government, therefore, must struggle with a diminishing income, which, on the assumption of a deadlock in congress, cannot be increased by added taxation.

The present administration, having a large reserve of currency in the treasury (but not of gold), may avoid the unpleasant expedient of making another bond issue, since it can meet deficiencies by paying out greenbacks it now holds. If there be no drain upon its gold through domestic hoarding, it may gain somewhat in its gold holdings, because the trade balance sends gold this way in the fall of the year. But with the return of spring the export of gold usually begins. If the senate should continue to refuse relief to the treasury, the situation may again become critical enough to give a check to business, and produce effects not greatly different from those we have recently suffered from. This, it must be confessed, is an unpleasant prospect; but it is useless to try and disguise from ourselves a contingency which we shall certainly have to face if McKinley be elected, but by a vote barely enough to carry him through.

It is, therefore, of almost as much importance, from a business standpoint, that the vote which carries him in be so large as to over-

whelm the silver party, as that Bryan should be defeated. A half-victory, with things as they are, would put the sound-money party at a serious disadvantage, in that it would find itself powerless to effect the needed reforms in legislation which are absolutely essential to putting our currency on a sound basis and giving to business interests the needed stability.

On the other hand, let us suppose that we have a sound-money tidal wave; that the vote be such as to leave Bryan only the conceded silver States of the extreme West and of the South. Suppose that his defeat be as complete as that of Greeley in 1872. In this case, the revulsion of popular feeling would leave the silver party in the senate not only in a hopeless minority, but disheartened and unnerved by the thrashing they had received. The forces of obstruction would melt away. Even the Democratic senators who had acted with the Bryan party would feel that they had submitted their policy to the popular verdict, and that the verdict had been one of overwhelming condemnation. They would have the physical power still to obstruct, but the moral force would be wanting. The only party remaining which would still have any vital force would be the small band of senators from the mining States, with whom the question would still be one of their pockets. Their power for effective harm would have gone, when they were left alone.

Supposing that we have such a victory as this implies, it is reasonable to look forward to a rebound in business corresponding to the depth of the previous depression. We should not have to wait till the new congress came in, either in extra session called by the new president, or in regular session in the December following his inauguration. The anticipated changes for the better would be "discounted" in advance by an industrial revival probably equal to that of 1879-80.

The chances are that the outgoing administration would not propose to the congress which meets in December any new legislation; or, if it did, it would be merely of a tentative character, designed to meet such emergencies as might arise before March. It would be natural to leave to the new administration the task of inaugurating or suggesting more radical measures.

What are these measures likely to be? The first, and one upon which all parties (except the irreconcilable silverites) will agree, would be one designed to give the treasury more revenue. It is conceded that the present revenues are insufficient. The treasury is paying out more than it is taking in, and the close of the fiscal year must inevitably see a large deficit, to meet which the treasury will have had to draw on its accumulated surplus, largely made up from the proceeds of bond sales. The dispute will come over the details of such a meas-

ure ; and the end will probably be reached by compromise. It is not to be supposed that any measure of an extreme protective character will be proposed, or, if proposed, could be passed. Protection is only an incidental issue in this campaign. The sound-money Democrats, who will contribute to McKinley's election, are not protectionists, and the Bryan party are not. Furthermore, the Republicans have had all they want of extreme high protection, and unmistakably are not inclined to try any more of it. Therefore, we may look to see a spirit of compromise displayed by both parties, and a measure for increasing the revenue adopted which will cause as little business disturbance as possible. The St. Louis platform plainly intimates that this is to be the Republican policy.

When it comes to dealing directly with currency measures, as apart from questions of revenue, it must be conceded that we are entering on more debatable ground. There is no unanimity of opinion in any party as to exactly what should be done,—that is, no unanimity outside of the Bryan people, who propose their free-silver cure for everything. There is no question definitely before the people now as to the lines on which our currency system shall be reformed, and therefore it cannot be said, after Bryan's defeat, that the country has said how such a reform shall be carried out. The only question that will be settled is whether or not we are to have free coinage of silver. It is possible that, in view of the diversity of opinion, congress may decide to appoint a commission of inquiry ; and that, the immediate needs of the treasury being provided for, no action will be taken on purely currency matters until the commission has made its report. If the make-up of the commission be good, and such as to inspire public confidence, its appointment would have a beneficial effect. It would be felt that nothing was going to be done in a hurry, and no rash experiments tried.

It looks as if it were certain that congress will have to be called in extra session as soon as the new president is inaugurated. If such a calamity as Bryan's election should befall the country, it is certain that he would call it ; in the nearly certain event of McKinley's success, it is difficult to see how he can avoid it. But we are now speaking on the assumption, not only of McKinley's election, but of his election by such a vote as will overwhelm the silver party. On this assumption, which supposes the silver party crushed, business will not wait for congress. The incubus of the silver scare being thrown off, the industrial forces of the country will spring into renewed activity, and the danger is more that there will be a sudden and enthusiastic expansion than that depression will continue. The idea, however, that foreign capital will rush into the country in untold volume is fal-

lacious. The foreign capitalist is not operated on by the same forces; he will be inclined to wait, to be cautious, and to satisfy himself that the improvement is permanent, before he ventures freely. But this will not retard the forward movement here. The domestic trade revival will be immediate.

How long shall we have to wait before this revival manifests itself? Probably less than two months,—that is, assuming that the indications become plainer that Bryan will be defeated. It may be considered certain that the election will bring out an extraordinarily large vote, probably the largest ever polled at a presidential election. Usually, when so large a vote is brought out, the results are of a very decisive character. We shall doubtless have some certain indications of what the results will be before the voting is done. Assuming that these indications are favorable to the sound-money party, we may look for a perceptible improvement in the industrial situation by the middle of October.

While no man can predict in detail what will be the industrial consequences of a sound-money victory in November (any more than he could the consequences of Bryan's election), we may, in the event of such a victory, surely expect some relaxation of the rigid retrenchment and repression which have characterized all industrial enterprises during the period of uncertainty. We can expect that the lessons of economy and close management learned during the bad years will bear fruit in the ability to conduct business profitably on closer margins; and that, as this is proved, the business ventures of the country will again move forward with a more nearly normal progress, on a sounder basis in themselves, and with less to suffer from wild-cat competition. A verdict of the country for sound money must necessarily rehabilitate our credit, at home and abroad, and loosen the now closed purses of the financial backers of industrial enterprise.

FAST TRAINS AS RELATED TO BUSINESS POLICY.

By H. G. Prout.

RUSKIN and our revered grandmother never had even a glimmering of the service of railroads to humanity, and their imagination remained forever dead to all that is stirring and grand in railroads, either physically or morally. Ruskin, with that moderation of thought and statement which his readers know so well, said: "I should like to destroy most of the railroads in England and all the railroads in Wales." To him the railroad was an evil thing, not alone because it disturbed the sweet serenity of nature, and because it was at best hopelessly ugly, but because of its debasing effect on humanity. The railroad was one of those instrumentalities which are destroying the independence, the gayety, the multifariousness of the individual man, and making him a poor, contracted little unit in the great machinery of life. Instead of wearing a picturesque velveteen jacket and singing in the fields and doing a variety of honest work, most of which he must contrive with his own head and carry out with his own hand, the modern man in a society modified by railroads is a pale and dirty and unpicturesque tender of machines, toiling among piles of bricks and mortar. Our grandmother never went so deep into the subject as Ruskin. To her the railroad was something which made a horrible noise, and destroyed her peaceful orchard, and scared away the birds and killed people in a dreadful way.

One must often sympathize with Ruskin and with our grandmother in these feelings toward the railroad, and yet they were not altogether right in their opinions, even on the esthetic side. There are few things more impressive than a great express train thundering along through the darkness. How it roars, how it flies, how the earth trembles beneath it! Surely the man who can stand without emotion beside the track and see it pass has but a feeble imagination. There is but one other thing that so impresses me with man's control of "the great sources of power in nature," and that is to stand of a dark and blustering night on the deck of a great ocean steamer, and hear the wind sing in the stays and see the black water rush past.

But in this age of the world the esthetic side of the railroad will seem to most persons of very trifling importance. The serious way to consider the railroad is with regard to its services to humanity, and here most of us differ radically from Ruskin and from our grandmother.

In a wise and brilliant address delivered to a very distinguished

company a few years ago Mr. Abram S. Hewitt said: "The Bessemer invention takes its rank with the great events which have changed the face of society since the time of the middle ages. The invention of printing, the construction of the magnetic compass, the discovery of America, and the introduction of the steam engine are the only capital events in modern history which belong in the same category as the Bessemer process." Through Bessemer's discoveries "the cost of constructing railroads has been greatly lessened, the cost of transportation has been reduced, and the practical result has been to reduce the value of food products throughout the civilized world; and, inasmuch as cheap food is the basis of all industrial development and the necessary condition for the amelioration of humanity, the present generation has witnessed a general rise in the wages of labor, accompanied by a fall in the price of food which it consumes. The working classes of our day are enabled to earn and to expend at least double the amount which was at their command in any previous age of the world. Sir Henry Bessemer has certainly been the great apostle of democracy."

It is not necessary to develop Mr. Hewitt's idea further. The great service of railroads to humanity has been in two principal ways: first, and most important, in reducing the cost of carrying materials and persons over the face of the earth; second, in making communication swift and comfortable. With the first we have nothing to do here, but I am charged by the editor of the ENGINEERING MAGAZINE with the task of telling something of the effects on humanity at large of increased passenger-train speeds, and especially of their effect on the business of the railroads themselves.

Frankly, I may say at the outset that I have only a very vague notion of what these effects have been. I have the less hesitation in making this confession because I am satisfied that no one else has anything but a vague notion. The whole inquiry must be more or less speculative, but, to bring it down for a moment into the realm of solid fact, in which my essentially unimaginative mind much prefers to dwell, we will attempt to get some measure of the increase of passenger-train speeds in recent years.

In 1880 there started from New York for Buffalo 10 trains every day which can be classed as regular passenger trains, besides emigrant trains, which latter we will leave out of the consideration. These trains ran over three different roads. The fastest of them made the journey from one terminus to the other in 14 hours, or at 31.4 miles an hour. The slowest ran at 21 miles an hour and was 21 hours on the way. The average speed per hour of these 10 trains was 26.3 miles an hour. In midsummer of 1896 there are running from New

York to Buffalo 25 passenger trains every day. These run over five different routes. The fastest is, of course, the Empire State express, which is timed to make the journey from one station to the other in 8¼ hours, or 53.3 miles per hour. It is not only timed to do this, but does it, summer and winter, year in and year out. The slowest train that we find running from New York to Buffalo makes 26.6 miles per hour. The average of all is about 34½ miles an hour.

In 1880 there were 14 trains starting out of New York every day for Chicago. The fastest of these made the journey at the rate of 27.1 miles an hour, and the slowest at 25.1 miles. The average speed was 26½ miles an hour. In the summer of 1896 there are 24 trains starting from New York for Chicago every day on eight different railroads. The fastest of them makes 39½ miles an hour, the slowest 26.1, and the average is 31.8.

The regular passenger trains starting daily from New York for Philadelphia in 1880 numbered 28. The highest speed made was about the same as the highest in 1896,—namely, 44.8 miles an hour. This includes one mile by ferry, which absorbs 13 minutes. The slowest train in 1880 ran at the rate of 18.7 miles an hour. In 1896 there are 47 trains running; the highest speed is 45.6 miles an hour, the slowest 16.3

From Chicago to Milwaukee the number of daily trains running in 1880 was 8, the highest speed 31 miles an hour, the slowest 25.3 miles, and the average 28.3. In 1896 the number of trains running out of Chicago for Milwaukee every day is 15; the highest speed is 39.2 miles an hour, the slowest 29.1, and the average 38. From Chicago to St. Paul the total number of trains starting every day in 1880 was 4. The speed was 24.8 miles an hour for the fastest, 22.1, for the slowest, and the average 22.2. In 1896 the number of these trains is 15 a day, the highest speed 32.6, the slowest 24.5, and the average 30 miles an hour.

Of course, this comparison could be carried on almost indefinitely, but it is a laborious one to make and these examples are enough to give a pretty accurate notion of the advance in service to the public, both in the number of trains and in their speed. The trains from New York to Buffalo have increased 2½ times in number and 31 per cent. in average speed. The speed of the fastest train has increased almost 70 per cent. From New York to Chicago the trains have increased 71 per cent. in number and the fastest have gained 45 per cent. in speed. From Chicago to St. Paul the number of trains has almost quadrupled, and the best speed has increased 31 per cent.

Having thus got some measure of the growth in the number of trains and in their speed in the sixteen years considered, we may properly inquire whether or not passenger travel has increased accordingly.

Unfortunately, we have not the passenger-miles for 1880. The first compilation made by Poor, of this indispensable unit of measurement, is for 1882. In that year the total passenger journeys made on the railroads of the United States amounted to 289,000,000. In 1895 the total passenger journeys were 507,500,000. The passenger-miles in 1882 were 7,688,500,000; in 1895 they were 12,188,500,000. The absolute increase in passenger movement is obvious enough from these figures, but was there relatively a greater passenger travel in the later year? In 1882 each individual inhabitant of the United States took 5 1/2 journeys by rail; in 1895 he took 7.2 journeys by rail. Or, using the more accurate measure of distance travelled, in 1882 each inhabitant travelled 146.7 miles, and in 1895 he travelled 174.1. It is sufficiently apparent from these figures that the use made of the railroads of the United States by the people of the nation increased greatly in the years considered; but so did the supply of railroads. Per mile of railroad in operation, the travel was actually less in 1895 than it was in 1882; that is, in 1882 there were 80,300 passenger-miles travelled for each mile of railroad worked, and in 1895 there were 67,400 passenger-miles for each mile of railroad. In other words, the public use increased, while the returns to the railroads decreased, all of which could be shown by figures into which we need not go.

We have now some rough measure of the increase of service rendered, and of the increased use made of the railroads by the public; but what does it all prove? Is the increased travel the result of higher speed, or is the increased speed the result of more travel, or are both the results, partly of each other, and partly of a great many other things? Any deduction from the figures alone will depend a good deal on the way the figures are arranged. But let us approach the subject by reason alone, setting aside for the time these figures, which, while they might furnish ground for much entertaining speculation, are not likely to help us in the search that we have undertaken,—namely, to find how train speed affects the volume of travel.

Probably increased speed is of more importance to those who live in the suburbs and do business in the great cities than to any other class. To these people a small gain in speed means a great gain in time. For instance, a man who lives about 15 miles away from the city terminal station will travel, going to and from his business, about 10,000 miles a year. The difference between 24 miles an hour and 36 miles an hour average speed will be a difference of 50 seconds per mile traveled, or, say, 140 hours for 10,000 miles, or 17½ days in a year, counting the business day at 8 hours, or 14 days a year for the mechanic or clerk who works 10 hours a day. Such an increase in average speed would be to the suburban dweller a clear gain of more

than half a month in each year, which would be available to him for business or for pleasure. It might make a difference of more than two weeks in his annual vacation, or it might make a difference of the income of more than two average weeks in the results of his business.

Or, we may look at this matter in another way, and assume that the time which the suburban dweller is willing to spend in travelling is fixed. Then an increase of fifty per cent. in the speed of the trains which serve him increases by that much the zone in which he can choose his home, giving him command of a greater variety of conditions, such as rents, taxes, schools, roads, water-supply, topography, etc. Or, such an increase of suburban train speeds will raise the value of real estate within a certain zone, and thus add to the common wealth.

All of this is so obvious that it seems superfluous to say it. It is equally obvious that, as increased speed of suburban trains adds to the wealth and to the comfort of mankind, so it will add to the revenues of the railroads themselves; and it is obvious that, other things being nearly equal, the railroad that gives the fastest service will be preferred by suburban residents. The result is a rapid development of its suburbs and its suburban business. A thin suburban traffic is a bad business. It is done at a loss to the railroad, and is unsatisfactory to the commuter, and the service must, in the nature of things, be poor. A dense suburban business is probably profitable. It is easily handled, considering its volume, and is likely to be as nearly satisfactory to the commuter as it can be made. But I have yet to know more than about a dozen satisfied commuters, and my knowledge of them is extended.

A characteristic instance of the increase of suburban speeds and of its effect comes from one of the big railroads entering Chicago. In eight years the average speed rose from about twenty miles to about thirty miles an hour, and in that time the volume of the suburban business more than doubled; but "the increase is certainly not due entirely to improved train service; more largely to other conditions."

There is still another advantage in high speeds for suburban trains. It is probably the best and the most available way of meeting the tremendous and inevitable competition of the trolley roads. For short distances they have advantages which it seems impossible to overcome. Their cars can stop anywhere to pick up passengers; they run so frequently that the passenger does not need to consider a time table, and they go within a few yards or rods of his door. Until trolley roads are driven off the highways,—which event is so far in the future that it is not worth considering,—steam railroads cannot compete with them generally for the very-short-distance suburban business; but, as distance increases, the higher speed which can be made by a railroad running its trains on its own right of way, free from the dangers and

interruptions of a public highway, will, at some point, begin to offset the convenience of the trolley road.

But, after the suburban zone is past, it seems, as a matter of reasoning, as if increased train speed would have little effect on the volume of travel until some long distance is reached. The gain of time in each mile can have a real economical value to the passenger only when it is multiplied by a great many miles, either because of the frequency of his journeys or because of the length of a single journey. So, for middle distances, it is doubtful if speed will increase travel much. Of course it is a very important matter in competition, but that it actually stimulates movement is doubtful. For instance, if the journey is 100 miles which the farmer, or the village storekeeper, or his wife, must take to go to the nearest large city for business or pleasure, or which one must take to get from one large town to another, the speed of the train probably has little to do with the number of the journeys. The difference between 30 miles an hour and 45 miles an hour is about two hours in the round trip; but, at best, to take the journey and to do a little business will break up a day, and the fare, at this distance, becomes an important sum, and two hours more or less does not decide whether or not the journey will be taken. The saving of time adds to the comfort of the passenger, and it adds to the wealth of the community, but it is doubtful if it adds much, or anything, to the revenues of the railroad. At any rate, we have considerable testimony that increase of travel has not been proportionate to increase of service for middle distances.

All these considerations grow in importance as distances increase, until we get up to some distance at which the time saved again becomes a factor that will decide in many cases whether or not one takes the journey. But, even among the s. ort, middle-distance journeys, there may be some exceptions to our reasoning. For example, we may take cases like New York and Philadelphia, or Chicago and Milwaukee, or the large towns on the line of the New York Central. In all of these large towns there is a considerable number of men whose time is valuable, who may be tempted to take more journeys if the round trip occupies four hours than they will take if it occupies five hours and a half. The Empire State express, for example, is said to have *created* a certain traffic, because men could go from one town to another and back and have some time during the business day in each of the two towns at the ends of their journey. But even in these cases the difference between the speed of the fastest train and that of the ordinary trains, when multiplied by the distance traveled, amounts to so little in time saved that it is not likely that it has much influence on the volume of travel. Convenient hours and frequent trains are

probably a great deal more important factors in increasing travel for those distances. But, when we get trains running between Jersey City and Philadelphia, or between Chicago and Milwaukee, at an average speed of 75 miles an hour, between termini the traveler will be able to save an hour and a half in the round trip. Then probably more journeys will be made, because of this one fact of better speed.

When the travel approaches 1,000 miles,—as, for example, from New York to Chicago,—every increment of the average speed has a meaning which it cannot have in short journeys. The difference between 26 miles an hour and 40 miles an hour is the difference of a whole working day. Or, it is the difference between a night spent in your own bed and a night spent on a sleeping-car. Obviously, such a difference must have an effect on the volume of travel. We cannot doubt that passenger movement is stimulated by the reduction of the time spent on the journey, but we cannot prove it.

In 1893 an experiment was tried from which many of us expected a good deal. In that year the New York Central Railroad and the Lake Shore put in service the famous "Exposition Flyer," which made the journey between New York and Chicago in 20 hours' actual time; or apparently in 19 hours' westbound and 21 hours' eastbound. The distance run was 964 miles, making the average speed 48.2 miles an hour, including nine stops, in seven of which engines were changed. This beautiful performance was enough to excite the enthusiasm of any person at all appreciative of the difficulties and excellencies of railroad work and capable of enthusiasm. In writing of the establishment of this train, I said: "While it is foolish to tempt fate by making a gratuitous prophecy, I should not be at all surprised to see the run between New York and Chicago made regularly in 18 hours within the next two years." There seemed to be excellent business grounds for such a reduction of time. Thirty-six hours between New York and Chicago meant (if one started in the evening) simply spending two nights on the way; it meant the loss of only one working day; and, to the hardened traveller, two nights on the way was no very serious matter. A reduction to 24 hours or 25 hours was, for most people, no saving of time, although it was a measurable addition to one's comfort; you still lost one working day. But, when the time was reduced to 20 hours, one could do a fair day's work in New York, leave there at 3 o'clock, arrive in Chicago at 10 o'clock the next morning, spend 4 hours in Chicago, leave there at 2, and be in New York again at 11 o'clock the next day. This journey I actually performed. I was away from New York 44 hours, and, by a little use of the telegraph, had four profitable hours in Chicago.

Here, one would say, was a reduction of time of real human value. It permitted one to do business in the two great cities in three consecutive days. It did not seem too much to suppose that it would induce a new movement of passengers, or, as folks say, "create traffic." In fact, however, the train was withdrawn at the close of the World's Fair, and in the three years that have passed since then there has been no reduction of time; which shows the risks taken by him who ventures to prophesy.

But this case really proves nothing. In the middle of 1893 the currency panic developed, and from that day to this our suffering nation has not been permitted to recover and to go on about its business under conditions of normal health. It is quite possible that, if business had been ordinarily good for the last three years, we should now have regular trains running between New York and Chicago at 50 miles an hour, including stops, and that these trains would pay. This would make the actual time between New York and Chicago 19 hours and 20 minutes by the New York Central, and 18 hours and 15 minutes by the Pennsylvania railroad. As, for good business reasons, the through time is held the same, the Pennsylvania would run a little slower, and make the 19-hour schedule. There are some topographical reasons why the Pennsylvania would be very willing to do this.

The attention of the public has been much occupied the last three or four years by accounts of very fast runs made for long and short distances, by regular trains as well as by special trains, and we are naturally led to inquire somewhat into the advertising value of high speed. Doubtless, it has a considerable value of this sort, but its value must be chiefly in securing competitive traffic and not very great in creating new traffic. The public knowledge that some of the trains of a certain railroad make extraordinarily fast time, advertises all of the trains of that railroad and this knowledge has an influence in diverting competitive travel. But even this is a matter to be considered with great caution. Other things being equal, the faster trains will take more passengers; but there are a great many other things that must be equal. Convenient hours, frequent trains and the regular fulfillment of the promise of the time-tables are all conditions that must be carefully borne in mind; and a condition as important as any and perhaps more important than any of the others, is the comfort of the passenger on his journey. Very likely the sum of all these conditions is considerably more important than speed alone. All of us must have met travellers, and particularly ladies, who have been made uncomfortable and even ill by being dragged fast over a crooked road and who have, ever after, preferred a slower train; and there are various other ways in which speed interferes with comfort. For

instance, if a fast schedule involves making a long run without a dining-car, and subjects passengers to the costly antiquities of a "buffet-car" lunch, we may be sure that that train will soon acquire a bad name among discriminating travellers. It would be indiscreet to name names here but the experienced reader can supply instances.

A fast schedule made at the expense of punctuality in arriving may do more harm than good; there are intelligent passenger agents who have no doubt that it does more harm than good. There are few things that irritate a passenger so much as to arrive behind time and few things that give the service of a railroad so bad a reputation.

Beyond all this we must remember that fast trains are a very expensive form of advertising. They must not only be run, but the public must be kept forever aware that they are run; that is, the trains themselves must be advertised. On the whole, even this aspect of our inquiry is not so simple as it seems at first thought.

Probably it is not worth while to follow this line of speculation any further, for, after all, it is mere speculation, and whether or not any man's conjectures on the subject are of interest or value depends on the strength of his imagination and on the knowledge of actual conditions which he can bring to the control of that imagination.

In looking over this article, three principal things seem to have been accomplished; (1) the fact has been made clear that in recent years there has been a great increase in passenger-train speeds, which we all knew, or thought we knew, before; (2) it has been shown also that passenger movement, actual and relative, has likewise increased to a very notable degree; and (3) it has been made quite apparent that the writer of the article is entirely unable to point out the relations between (1) and (2). In justice to him, however, it should be added that he has probably suggested the law of the social uses of high speed,—namely, that high speed is really useful to mankind only when the increment of speed is multiplied by many miles, either because of frequent journeys or because of very long journeys.

Finally, when one speculates on this subject of the causes of the growth of railroad travel, he should not forget one great influence which has not yet been mentioned; - an influence which on some railroads seems to be more important than all others. That is the influence of the man who sits up nights thinking how his railroad can be made useful and attractive to the public and how the public can be taught that it is useful and attractive,—the man who spends active days carrying out the schemes which his fertile brain has contrived. We must never forget the influence on all this question of the ingenious, the judicious, and the untiring G. P. A.

THE ECONOMY OF THE MODERN ENGINE ROOM.

II.—THE PROBLEM OF ENGINE SELECTION.

By Charles H. Davis and John S. Griggs, Jr.

ON account of the development of the steam motor from its primitive commercial form as a vertical beam engine for mine-pumping to the triple-expansion and quadruple-expansion high-pressure engines of the present day, with all the intermediate types still on the market, and for all of which remarkable claims are made, the difficulties which confront the would-be purchaser whose familiarity with the different types is frequently of the most elementary character are often very great, and his intelligent selection of a machine best adapted to his own peculiar needs is not usually forwarded by the strenuous representations made by the manufacturers or their agents, who pour in upon him until he almost believes that a high pressure multiple-expansion condensing steam plant, with coal costing ninety cents a ton, for a small plant, is a better investment than a single-cylinder engine running with moderate steam pressure. This article is intended to clear up some of these difficulties, and make the path of the purchaser a smoother one.

There are so many duties required of an engine, and so many different conditions to be met and overcome, in order to make it possible for the manufacturer to show a dividend at the end of the year, and also at the end of the tenth or twentieth year, that it must be evident at the outset that no one machine or type can satisfy all of these requirements. For purposes of comparison, then, we take the single cylinder, the compound or double cylinder, and the triple-expansion machine, and consider in detail the merits and advantages of each.

The question of steam consumption is one of the first to confront us; varying, as it does, so largely, it becomes one of the most important factors in the operation of an engine, and, therefore, in its selection.

Table No. I, showing the average amount of dry steam used per h.p. hour by the various types and under different conditions, is compiled from actual tests, made in most cases for the owner or manufacturer, to fulfil a guarantee, and therefore under conditions conforming more nearly to the ideal as to loads, steam pressures, etc., than is usually possible in the actual operation of a plant; hence the actual performance of any of these machines might naturally be expected to show a slightly greater consumption of steam and coal in daily or yearly operation. However, all having had similar advantages in the tests, it is possible to compare the results.

TABLE NO. I.

STEAM CONSUMPTION IN POUNDS PER HORSE POWER HOUR.

TYPE OF ENGINE.	STEADY LOAD.		Variable Load 50% to 125%		Extreme variations. Railway work, etc., 0% to 150%	
	Non-Con.	Con.	Non-Con.	Con.	Non-Con.	Con.
High Speed, Simple.....	32	28	34	30	36	31
High Speed, Compound....	23	18	25	21	27	22½
Slow Speed, Simple.....	25	21	28	23	31½	26½
Slow Speed, Compound....	20	15	22½	18	26	23
High Speed, Triple expansion	17½	13	20	16	..	..
Slow Speed, Triple expansion	14½	12½	17	15	..	..

In the operation of a steam plant there is a certain amount of flexibility in the expense account, it being possible to vary some of the items materially, while others are nearly fixed. The engine-room attendance for the different types of machines in stations of equal capacity will be about the same per h. p. per annum, though, of course, this can be reduced in large central stations with several units, by different methods, such as automatic lubrication and other labor-saving devices, just as fire-room attendance in extensive steam plants is cut down by mechanical stoking. The character and cost of the fuel available then, will determine the type of machine adapted to give the most economical results, taking into account the cost of the apparatus,—except in some special cases, as noted hereafter.

To show the vast difference resulting from the use of the extremes, and to enable the purchaser to see clearly what is often misunderstood, Table II has been prepared. The cost of coal varies so that it is only possible to take a few cases. Along the lakes, and in the vicinity of the mines, where freights are low, a dollar and a half per long ton is about the average; on the New England coast and in New York, where coal from the southern fields can be delivered without transshipment, it is about three dollars; and in the interior, far from the mines, with high freight rates, it may run from four to five dollars, or even higher. The evaporation of water per pound of fuel is not a fixed quantity either, by any means, as we have seen in earlier articles, but in plants put in at the present time at least ten pounds of feed water should be evaporated into steam for each pound of coal burned under the boilers. This can very probably be increased by some of the numerous forms of economical boiler settings, or by careful firing; so the manager who makes use of the following table can readily make a percentage deduction or increase for any particular rate. This table shows the cost of fuel per annum for a five-hundred-

horse-power plant running ten hours a day three hundred days a year. This will hardly be considered a large plant in these days of larger things, yet is of sufficient size to cover a great many existing or proposed stations; deductions for larger or smaller units can be easily made. These costs are computed for factory plants from the steam consumption in Table I, with an allowance of seven per cent. for banking fires and getting up steam in the morning; for electric-railway or central-station work, where the run is longer and the time of idleness thereby shortened, this would be considerably less.

TABLE NO. II.

COST OF COAL PER ANNUM OF A 500 HORSE POWER ENGINE.

TYPE OF ENGINE.	STEADY LOAD.					
	Non-Condensing.			Non-Condensing.		
Coal per ton.....	$1.50	$3.	$5.	$1.50	$3.	$5.
High Speed, Simple.....	3440.	6880.	11467.	3010.	6020.	10033.
High Speed, Compound ...	2473.	4945.	8242.	1935.	3870.	6450.
Slow Speed, Simple.....	2688.	5375.	8958.	2258.	4515.	7525.
Slow Speed, Compound.. .	2150.	4300.	7167.	1613.	3225.	5375.
High Speed, Triple expan...	1879.	3758.	5263.	1397.	2793.	4656.
Slow Speed, Triple expan...	1559.	3117.	5197.	1344.	2688.	4479.
	VARIABLE LOAD, 50% TO 125%.					
	Non-Condensing.			Condensing.		
Coal per ton.....	$1.50	$3.	$5.	$1.50	$3.	$5.
High Speed, Simple.....	3655.	7310.	12183.	3225.	6450.	10750.
High Speed, Compound ...	2688.	5375.	8958.	2258.	4515.	7525.
Slow Speed, Simple	3010.	6020.	10033.	2473.	4945.	8242.
Slow Speed, Compound....	2419.	4338.	8063.	1935.	3870.	6450.
High Speed, Triple expan..	2150.	4300.	7167.	1720.	3440.	5733.
Slow Speed, Triple expan...	1828.	3655.	6092.	1613.	3225.	5375.
	EXTREME VARIATIONS, 0% TO 150%.					
	Non Condensing.			Condensing.		
Coal per ton.....	$1.50	$3.	$5.	$1.50	$3.	$5.
High Speed, Simple.....	3870.	7540.	12900.	3333.	6666.	11008.
High Speed, Compound ...	2903.	5805.	9675.	2419.	4838.	8063.
Slow Speed, Simple.....	3386.	6772.	11188.	2849.	5697.	9496.
Slow Speed, Compound ...	2795.	5590.	9317.	2473.	4945.	8242.

The steam pressure calculated to give the best results with simple engines is from 80 to 100 pounds; for compounds, from 120 to 140 pounds; for triple-expansion, 160 to 180 pounds. Quadruple-expansion machines are used only in very large plants, usually when space is much restricted, and where it is possible to carry very high press-

ures. The best examples are found on the fast ocean liners, and a discussion of their merits hardly comes within the scope of this paper.

While the cost of coal is the principal item of operating expense, aside from the labor, the oil and waste used in the engine room frequently amounts to a large sum, and there can be no doubt that a great deal of this is absolutely wasted by the engineer in his endeavor to keep everything cool. Suitable oil receivers and filters reclaim a portion that goes into the oil cups, but much too large a proportion is never recovered. Engines which in their design have had some provision made for automatic lubrication are to be preferred for most classes of work, if too much has not been sacrificed in other details to gain this end. An arrangement which provides for an excess supply of oil on all running parts, to be returned to a tank or receptacle and used again and again, is probably the simplest and best. Most manufacturers now-a-days will guarantee oil consumption as well as steam economy, and their representatives can so instruct the operating engineer, when starting a plant, as to secure such results. A system such as is used by railway managers with their locomotive engineers could be used with profit in stationary-engineering practice. The oil used on a five-hundred-horse power engine in a year will vary in cost from one hundred or one hundred and fifty dollars for an automatically-lubricated simple engine to five hundred or even higher for a cross-compound condensing machine; if the engine room is kept clean, the amount of waste will be in proportion,—from ten to fifty dollars; this includes the cylinder oil as well as the engine oil. The internal friction of a machine, which must be deducted from the horse power shown by the indicator cards, is often much too large, and should always be considered in selecting a machine. Simple engines should run at friction load of not more than three to five per cent. of their rated capacity, and compounds at from eight to ten per cent. Friction is absolute loss, which should and can be greatly reduced; attention to this subject will repay the purchaser. The cost per horse power of simple high-speed belted engines from twenty-five to three hundred horse power ranges from twenty to ten dollars; when arranged for direct coupling to dynamos, the cost is increased from fifteen to twenty-five per cent. Slow-speed simple engines, one to five hundred horse power, cost from eighteen to eleven dollars. Compound high-speed, one to five hundred, cost from sixteen to nine dollars. Compound slow-speed machines, one hundred and fifty to one thousand horse power, vary from twenty-one to twelve dollars. Triple-expansion, from four hundred to two thousand, would be from twenty-three to ten dollars. It is evident, then, that the installation of an expensive Corliss compound condensing plant would not be war-

ranted in a station where fuel is cheap, as the additional expense, when compared with a simple engine plant with its smaller foundations and greater simplicity, would probably balance the saving in fuel resulting from the compound machine, besides having the advantage of doing away with the somewhat complex arrangements of the latter rig.

The regulation in speed required of a machine, as determined by the character of the work to be done, will also influence the choice. In street-railway and rolling-mill work, where there are extreme and sudden fluctuations in the load, a considerable variation in speed, with proper precautions to prevent wreckage, is permissible, while in the more exacting service of cotton and silk mills, and electric lighting, where such variations would do serious harm to the product, a much more evenly running machine is demanded,—a demand which has developed the remarkably close governing devices now in use. There are cases in which large fluctuations in the load and close regulation are both required, as in buildings where it would often be desirable for electric elevators and lights to be run on the same circuit. This indicates the perfection which we hope to attain, and towards which very gratifying steps have been made; although complete success has not yet rewarded the efforts in this direction, its attainment is only a question of time. Generally speaking, poor regulation means lower economy in operation, and is to be avoided; and, where electric machinery is used, this may do serious damage to certain parts of the system. Short-stroke high-speed engines, on account of the greatly increased number of times per minute that steam is admitted to the cylinder, and the consequent shorter intervals during which the momentum of the revolving parts is expected to maintain the speed, usually give much closer regulation than the slower and longer-stroke machines, and are, therefore, to be preferred to the latter in special cases. Owing to the slower recovery in long-stroke machines, the fly wheel has to become the receiver for the energy, giving out towards the latter end of the stroke the excess absorbed during admission of steam, which accounts for the variation from end to end of the stroke so noticeable in large horizontal slow-running blowing engines, and others of that kind. It would be possible, of course, even with this type of machine, to get almost perfect uniformity of speed by the use of enormously heavy fly wheels, but it is not feasible commercially. This brings us naturally to the question of fly wheel, and the frequent accidents due to rupture thereof; and in this connection it must be remarked at once that it is nothing against the wheel that it breaks, for its failure to hang together is almost always due to the failure in some other part of the mechanism, and to the fact that the tensile strength of cast iron has a pretty well known limit,

beyond which centrifugal force will surely go, if allowed. Wheels should and can be designed for extreme variations of speed, but they can all be broken by systematic carelessness. All engines of this class are provided with automatic devices to prevent the "running away" of the machine, but, when the governor is blocked up to allow for heavy loads, the results can be predicted with great certainty.

While the foregoing may assist the purchaser in his quest generally, there are particular cases and conditions which outweigh questions of economy,—for instance, the very extensive use of steam engines for isolated electric plants in modern hotels, apartment-houses, and high office-buildings. In these structures one of the first considerations is the space which can be given to the electric plant, and it is usually all too small, prohibiting the use of belted apparatus, even if the combined efficiency was as high as that of the direct-coupled engines and dynamos now used almost exclusively. In such plants, where the exhaust steam is almost universally used for heating the building, or for domestic purposes, the best machine to use is the single-cylinder one; for the pressure required for the heating system often runs higher than five pounds, and this back pressure on the low-pressure cylinder would nullify all the good effects that could be obtained from compounding under favorable circumstances. This throws most of the load upon the high-pressure cylinder, which would then cut off much beyond its economical point, and probably make a poorer steam showing than a simple machine of the same capacity. In places where the load on the machine is a variable one, as for elevator service and electric railways, where the maximum load is frequently, for a few seconds at a time, double the average load, the mistake has been made of putting in engines altogether too large for the work. This has happened on account of the danger of straining the machine, if its cylinders and frame are designed for taking care of the *average* load economically, as the frame is not heavy enough to withstand the severe shocks.

The result is that the larger machines installed are running a great deal of the time at a most extravagant steam consumption. This can be overcome, and much better results obtained, by using the large frame as before and putting on this frame cylinders of a size to develop the average load at the most economical point of cut-off; their regular operation will then be as near as it is possible to get to the theoretical, and, by means of the automatic governor, steam will be admitted for the maximum power when required. The smaller cylinders render the first cost slightly less than the standard, and the cost of operation is also greatly reduced. How great this difference is is shown by a test of a compound engine, which, with cylinders more than twice too large for the average work, required twenty-five pounds of steam per horse-

power hour, and, when loaded to its capacity under favorable conditions, showed an economy of sixteen pounds per horse-power hour.

There are several other cases besides that of the office-building where the choice of a proper machine cannot be made absolutely by consulting the table of fuel costs. Where a manufacturing plant, on account of the nature of the product and the raw materials used, has to be located in the wilderness, far from the base of supplies, and often long distant from even ordinary machine-shop assistance, simplicity of construction is absolutely demanded, even at the expense of some other things. The shutting down of the engine for a few days, throwing the whole working force out for that time, while waiting for some small repair part to be supplied from the factory, would more than neutralize the economy attained by the complex machine. This chance of accident is, of course, increased in the machine having the complicated mechanism, which complication would be entirely warranted in large manufacturing centers. In this connection the question of the condenser may properly be considered, as it is an important adjunct to the economical success of many plants. It is almost unnecessary to say that the condenser should always be so connected to the exhaust from the engine that the engine can be used independently, exhausting into the atmosphere when repairs are necessary to any part of the condensing apparatus, or when the supply of condensing water gives out. At such times the power of the plant, if it be properly designed, can be brought up to its "condensing rating" by an increased steam pressure, or, if this be impossible, the governor will take care of the increased power required from the engine itself, cutting off the steam later in the stroke.

The use of the condenser is to be recommended in large plants pretty generally, and usually shows an improvement in the coal bills, when compared with the same plant without the condenser, of from ten to twenty per cent. In cases where a sufficient supply of water for condensing purposes is not available, some arrangement which provides for the cooling of the heated water of condensation after leaving the condenser pump, whereby the same water can be used again and again, has been used with advantage, although its continued efficiency has yet to be proven. Jet condensers being used for this arrangement, the addition of the condensed steam from the engine to the condensing water in circulation through the system is sufficient to maintain the amount necessary against all ordinary leakage, entailing no extra expense for water-supply. An "air condenser," for the double purpose of reducing the back pressure in the heating system of a building and at the same time furnishing hot air for indirect heating, is used in some places with success at the tail-end of the heating circuit.

The proper ratio between the cylinders of a compound engine has

been the subject of much discussion, but it is now pretty generally agreed that, when running condensing, the best results are secured with a ratio of 1 to 3½ or 4, and on very large units even as high as 1 to 4½; when a machine is to be used non-condensing, the ratio should be somewhat smaller, ranging between 1 to 2½ and 1 to 3½, increasing with the size of the machine; where an engine is to be operated with the condenser a portion of the time only, a ratio of about 1 to 3½ will give best results. Similarly, the ratio for triple-expansion machines between the high- and low-pressure cylinders, when condensing, should be between 1 to 7 and 1 to 8; when non-condensing, from 1 to 4½ and 1 to 5½. The form of compound used, whether cross or tandem, depends somewhat on how the power-house has been designed. Other things being equal, the tandem recommends itself on account of smaller floor space, simplicity of construction, only one set of reciprocating parts, smaller friction loss, and lower first cost. The saving in engine-room area reduces the investment for real estate and power-house. Better balance can be obtained in the cross compound, due to the cranks being set 180 degrees apart. It is also possible, when one side of the cross compound is disabled, to disconnect, and run the other half at reduced load.

Other points to be considered are the general safety appliances for the regulation and operation of the machine, and chief among these should be considered the governor, which does not receive half the care and attention which its important position demands. A thorough inspection of the governor at regular intervals should be made, for the same reason that indicator cards are taken,—to insure the continued economical operation of the plant. One of the most frequent causes of disaster to an engine is the presence of entrained water in the steam as it comes to the throttle, and, where this is at all likely to occur, separators should always be used, and, when used, must be as near the engine as possible. Water in the cylinder, either due to priming in the boiler or cylinder condensation, is apt to cause trouble, and some efficient form of cylinder relief is as important as the safety-valve on a boiler, and must be of such character that its operation is certain, with ample area, and so arranged that it can be renewed, in case of an accident, when no other damage has been done, without stopping the machine and at slight expense. Proper arrangement of drip piping, check valves, and exhaust, to prevent the drawing in of water when the machine is being shut down, should also be made, but the details can hardly be considered here.

Whether vertical or horizontal engines should be used in any particular case, aside from the question of floor-space, usually depends on the personal inclination of the purchaser; there are certain advantages

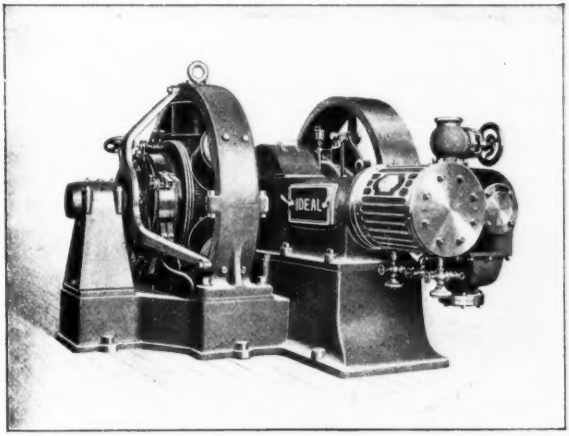
in each form. Considered mechanically, the vertical machine, with its reciprocating parts all supported by the brasses and pins where adjustment for wear can readily be made, and provided for in the design, has evident advantages over the horizontal, in which wear takes place inside the cylinder, both on piston and cylinder walls. With proper lubrication, however, this wear is very slight, and in the horizontal machine we have greater accessibility of the working parts for examination and removal, in case of necessary repairs. In running vertical machines, in places where quiet running is essential, it is impossible to get symmetrical indicator cards from both sides of the piston on account of the weight of the moving parts, which add to the pressure in the downward stroke, and detract from it in the upward stroke. This means a slightly increased operative cost, owing to the imperfect steam distribution. Increased head room is necessary, both for the machine and the space required to remove pistons and rods. Single-acting vertical machines with double cylinders, of which the Westinghouse and Willans are very good examples, have been designed to overcome some of these disadvantages, and are used with great success in numerous cases. European practice regarding vertical engines is very different from that with which we are familiar in this country, as the horizontal type is almost unknown, the other style being used for mill work and general power purpcses everywhere; this can probably be traced back to marine practice. There can be no doubt of the fact that in the ocean steamship we have the best example of economical steam development and utilization, which has resulted, of course, from the necessities of the case, where coal consumption is all important for the double reason of first cost and limited storage room; of course, the ordinary stationary steam plant is not to be compared in size with the marine plant, but there are some lessons to be learned from the latter, and one of the most important is the influence of high pressure on the economy. Locomotive engineering points in the same direction. Recent tests made by the Chicago & Northwest Railroad on fast passenger locomotives, carrying a pressure of from 180 to 190 pounds, with the ordinary slide valve, show an economy of 24 pounds of steam per horse-power hour. This is at first rather surprising, accustomed as we are to consider the locomotive as an extravagant machine, but, looking at the subject thermodynamically, remembering that it is really as a heat engine that the steam engine must be considered, and that the range of temperature gives it its efficiency, it is not so great a cause for astonishment. The general tendency of the times is towards higher pressure, undoubtedly, and, if it can be used to advantage with safety under conditions giving strains as severe as those to which a locomotive is subjected, we are certainly warranted in

going as far, at least, in stationary practice, under much more favorable conditions. We believe that the next ten years will see a still greater advance in this direction.

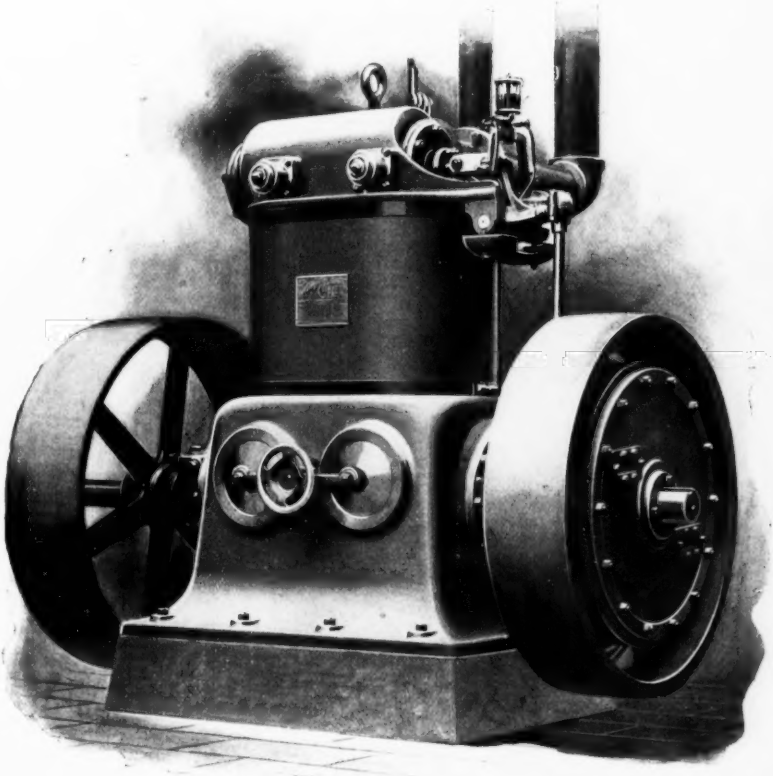
After the purchase of the engine, another very important factor in its successful operation is the foundation on which it rests. This should always be the subject of correspondence with the engine manufacturer, as his experience in this line with his own machine enables him to suggest what will give the best results ; and, where possible, the foundation should be put in and fully guaranteed by the engine-builder. The purchaser will then know in advance what the machine will cost, complete ; a "cheap" engine often requires a much heavier foundation than one costing more in itself. Further, the engine should always be assembled and erected on the foundations by the builder. A clause in the contract requiring the manufacturer to operate the machine for a short period protects both parties, and gives the owner's engineer an opportunity to gain information as to the proper care of the engine from those most familiar with its details, and therefore best able to instruct. Particular attention should be given to the "balance" of a machine when running at normal speed. Perfect balance means less wear and tear on all the parts, and longer life. Absence of vibration secured by enormously heavy foundations to which the engine is rigidly bolted is to be avoided ; the strains are present, with every reversal of motion, even if hidden, and will tell in the end. All of the better class of high-speed engines can be run without fastening to the foundations, and are usually so run and tested before acceptance, and then bolted down.

In electrical work a large proportion of the engines now-a-days installed are of the direct-coupled type. The principal advantages of such an arrangement are the great saving in space, which in a large station materially reduces the size and cost of the power-house ; the reduction of the losses by friction in belting and counter-shafting ; the possibility of running slower-speed generators of higher efficiency ; the better appearance. In engines for this class of work the shaft should be a solid steel forging to which the dynamo armature is keyed direct. The use of a coupling is quite unnecessary, if the shaft and working parts are properly proportioned to withstand the strains that may come even with short circuiting, and, where space is so important a consideration, it seems useless to add to it when nothing is gained. The cut of the single-cylinder direct-coupled Ideal engine shows one of the standard machines used for isolated lighting and power, while the Reynolds-Corliss machine is a familiar type in large electric-railway stations.

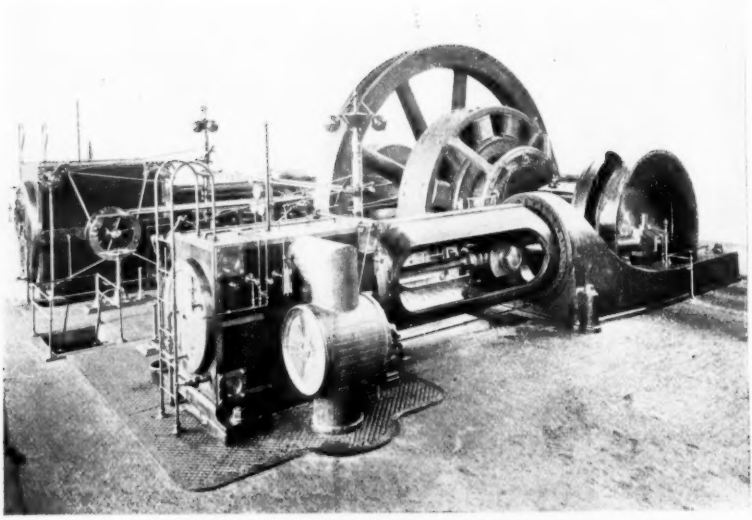
Where belting is necessary, and the conditions allow, the use of several small units, advantageously located through the works, will



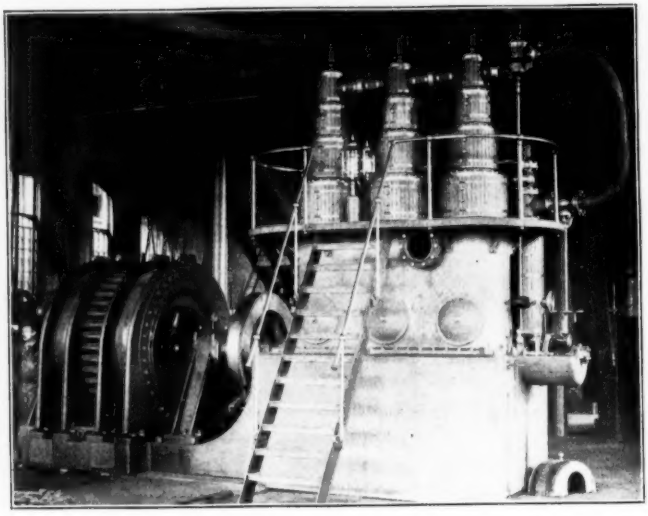
THE IDEAL—A SIMPLE DIRECT-CONNECTED ENGINE.



THE WESTINGHOUSE COMPOUND ENGINE.



THE REYNOLDS-CORLISS ENGINE. EDW. P. ALLIS CO.

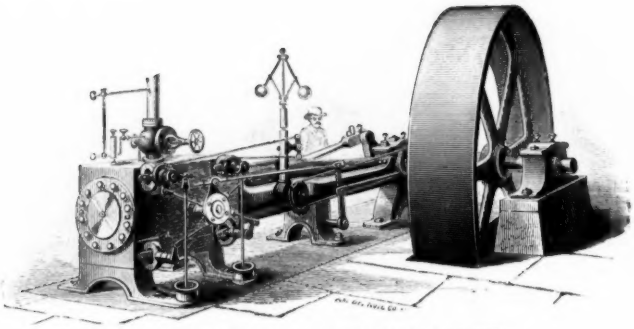


THE WILLANS TRIPLE-EXPANSION ENGINE.

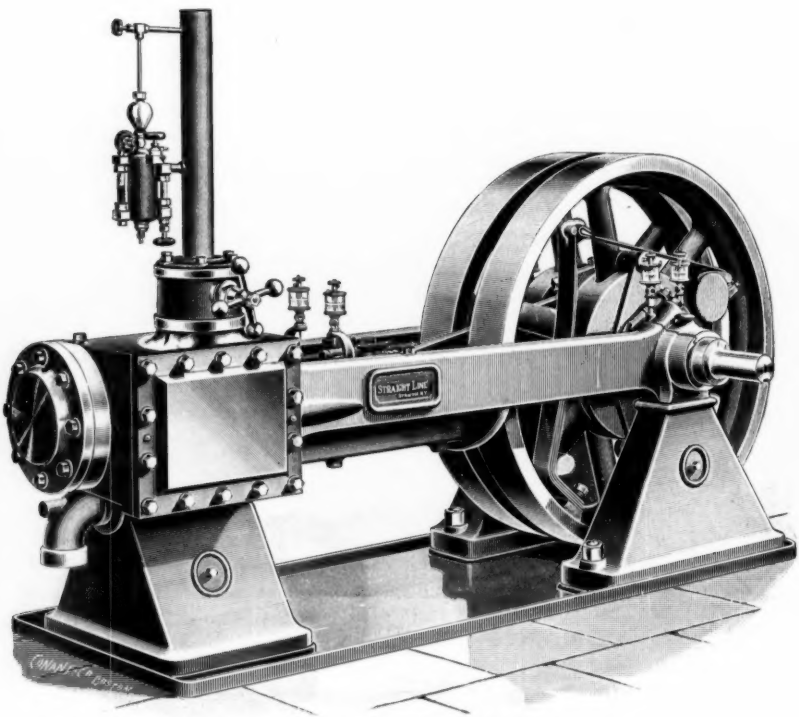
give better results than one large machine. By following this plan long lines of main and counter-shafting and gearing can be dispensed with, and the different departments can be shut down at will, without interfering with the rest of the plant. In the old way, with a central source of power, more than half of the indicated power of the engine was often lost in friction; this power, while originally developed at great economy, if considered at the engine alone without regard to work done, was really very expensive. One of the single-cylinder machines that has been very largely used for this class of work is the Straight-Line shown in the cut. There are cases when it is not possible or advisable to so divide the units, and where an economical prime mover is desired, which would call for a single slow-running machine. The Watts-Campbell is a good representative of this class, and its general features are shown in the illustration.

Essential to the general design of the machine are the proper proportions of the pins and shaft to the cylinders. The development of a class of work giving severe and suddenly-applied loads to a machine has brought a general revision of these details in the design of present engines as compared with those generally in use twenty years ago, and the running parts are now considerably heavier. Special attention should be paid to this in looking over specifications; while no rules or formulae can be given, it may be said that, of several engines with equal cylinders having different-sized shafts, and crank and cross-head pins, the one in which these are largest is usually to be preferred. None of them are too large. So, too, the general character of the workmanship and material entering into the machine must be noted: a well-designed machine, if poorly built, is as poor an investment as a "cheap" article of any kind. The exterior finish, while often very noticeable and pleasing to the eye when well done, is not as important as care and attention in the fitting-up of the running parts. Better a dull, black machine with rough nuts, that will run steadily and economically with the minimum of repairs, than a highly-polished engine stopped frequently for adjustments.

Although not included in the steam line, this subject would hardly be complete without some reference to the gas engine. Up to the present time the gas engine has been used principally where small power was needed, not warranting the expense of a steam plant and engineer, where close regulation in speed was not essential, and where an engine would run with little attention. But there are a few machines in this country in electric-lighting service, as large as 100 horse power, which have been running for two or three years very successfully. They are still in rather an elementary stage, compared with steam-engine practice, but their perfection is greatly to be desired, as



THE WATTS-CAMPBELL—A SIMPLE CORLISS ENGINE.



THE STRAIGHT-LINE ENGINE.

their use removes one complete link from the thermodynamic chain, cutting out, as it does, the boiler, and burning the fuel directly in its cylinders. Careful tests show an indicated horse-power hour with a fuel consumption of less than 1¼ pounds, which is equal to about the best that is attained by the use of the triple-expansion steam engines. Further development of the gas engine, tending to simplify its present complex method of mixing air and gas, and the governing devices, will be watched with great interest by the engineering profession.

Great caution should be exercised in accepting extravagant guarantees on new machines. The results to be expected from old and tried designs are well known, and it is extremely improbable that any new features can be introduced which will make any startling changes in present conditions; but manufacturers are often willing to make unusual promises on new machinery, which they had better be allowed to try on some one else.

Recapitulating briefly, we see that high-speed engines should be used in all cases where the power required is small and the total cost of fuel relatively low; for direct-connected electric-lighting work; and in large works where a distribution of the units can be made profitably. Compound engines of this type are to be selected for somewhat larger work, for small electric roads, and central-station or small municipal electric plants. Simple slow-speed engines will run to greatest advantage in factory service where the loads are moderately steady and not large enough to warrant compounding, and where very close speed regulation is not essential. Compounds should be used as soon as the size shows a sufficient economy, particularly if water is available for condensing. Slow-speed compounds should also be adopted for large electric railroads, where the percentage fluctuation is not as great as on lines having only a few cars. Triple-expansion machines should be chosen only when the units are large and the loads are pretty steady, or where the cost of fuel is so high as to make it necessary to take every step to reduce the coal bills. This summary can be only general, as other conditions will often make the choice a difficult one, and render the expert advice of an engineer necessary, as Dr. Emery has pointed out in his article on boilers.

In conclusion, there is one thing necessary to make the steam engine efficient after having secured the type best suited to the owner's particular purpose, and that is intelligent operation. Given these two,—a proper engine and a careful engineer,—the owner can rely on getting the best results, and give his attention to other details of his business.

AN ARRAIGNMENT OF AMERICAN CITY ARCHITECTURE.

By E. C. Gardner.

IN these closing years of the nineteenth century we are doubtless the richest, most versatile, most competent, and most enterprising people on the face of the earth. Perhaps this is unfortunate; perhaps we are too rich, too enterprising, too "hustling." Perhaps the inevitable result of this swift accumulation and vigorous growth is that we do many things that were better left undone, and often fail to make good use of our too rapidly acquired wealth. To be accused of an inordinate desire to "make" money, with not excessive scruples as to how it is made, and scant consideration, amounting almost to contempt, for the intellectual and moral qualities likely to be sacrificed in this pursuit of mammon, is by no means the most serious charge that can be brought against us. Neither is the reminder that a fool and his money are soon parted the hardest thing that one who has squandered his inheritance has to bear. When his money is worse than wasted; when he has not simply nothing to show for it, but something worse than nothing, a permanent record of his own folly, the tablet whereon it is written placed where it can be seen and read of all men,—his condition is enough to make the angels wonder and posterity weep.

Yet it is undoubtedly true that the charge of reckless folly can be made with justice against the majority of those who have been able to record their ignorance of architecture in brick and stone and iron,—that is, those who are responsible for the buildings along the streets of our cities. It is quite within bounds to say that nine-tenths of the structures devoted to commercial uses, three-fourths of our municipal and public buildings, and at least one half of our churches are, as regards their so-called architectural qualities, permanent monuments of ignorance, vulgarity, and incapacity. If all this is really true,—and it will at least be difficult to show that it is not,—it is surely time to consider how the enormous waste involved can be arrested.

If architectural excellence were a mere matter of taste concerning which there is no room for dispute, it would be idle to discuss the subject. It is not; it is a matter of knowledge, of well-trained judgment, of clear esthetic perception and practical skill. No sensible man needs to be advised that his opinions on matters with which he is unfamiliar are of little value. Why should he, when he is ready to erect a con-

spicuous building on a public street, insist that his taste in architecture is correct and worthy to be followed? He has never made a study of the art; he is not even familiar with the best work that has been done, and is too ignorant of the principles that underlie all good work—probably never suspected there were any—to distinguish the good from the bad. How can such a man dare to erect on a public street a building which, though it please himself, defies the criticism and scorns the approval of those who alone are capable of judging it correctly? Many a good man and true would rather hear his wife and

CHAMBERS STREET, LOOKING WEST FROM BROADWAY, NEW YORK.

A CHIGAGO SKY-SCRAPER.

children sing nursery songs to the accompaniment of an old tinkling piano than listen to the grandest harmonies of the great masters of musical art; if such were not his preference, at least for a part of the time, he would be an unsatisfactory husband and father. But, if he were allowed to select the music to be played in the public square, like the secret melody of Memnon's statue, every morning at sunrise through coming generations, would he trust his own unmitigated ignorance? Not unless he was one of those who rush in where angels fear to tread. Architecture, in apt and graceful figure, has

been called frozen music. A more accurate comparison for the most of what we call our street architecture would be a dull, discordant, senseless noise, devoid of harmony or rhythm.

It is an extremely rare thing to find a business block—one of the multitudes on which the average business man inscribes his name in lasting bronze or granite, and which he hopes will be a source of family pride as well as of substantial income to his great-grandchildren —that, by reason of its external architecture, can be called a thing of beauty and a joy forever. We seldom find a building to the "making over" of which any objection is made on the ground that a change will injure its appearance (the Bulfinch front is the one conspicuous

ST. JAMES STREET, MONTREAL.

LOWER BROADWAY, NEW YORK, LOOKING NORTH.

instance to the contrary, and there sentiment comes in for a share of the motive); we seldom find a building which an artist (excluding photographers) would for a moment think of introducing into a picture, even as a subordinate detail,—seldom one before which an intelligent company of sight-seers would involuntarily pause in order to admire the dignity of its form and the original beauty of its decoration. There are buildings enough that bear some burden of carved stone or stamped copper, some terra-cotta modeling or colored glass,

which one who has never studied stone carving, modeling in clay or metal, or "art glass decoration," will gaze upon in round-eyed and open-mouthed amazement. He is sure it must be wonderful, because it surpasses anything he has ever seen before. True, it may surpass the rest in ugliness; but how should he know in which direction to look for merit? In truth, he knows just as much about it as he would of a book written in an unknown language. He may see that the paper of the book is good, the type clear, and the binding strong,

A CHICAGO CORNER.

but, as for the real book, it may contain the wisdom of the ages, or it may be a collection of all things commonplace or vicious.

Even the most thorough education will not make all men architects, artists, or musicians. There are those who will never in this world be able to distinguish one tune from another; others who are hopelessly color-blind; still others who appear to be form-blind—to whom a line of beauty is an unknown object—who have apparently no

A MINNEAPOLIS EXAMPLE OF THE HIGH BUILDING.

LOOKING WEST ON KING STREET, TORONTO.

VIA NAZZIONALE, ROME.

perception of intrinsic grace, no standard of refinement and elegance but familiarity,—that is, fashion. It is a blessed thing for humanity that the face of every mother is beautiful to her children, however it may seem to others. It is a deplorable thing for art that most men can see good only in that which is familiar, especially if it happens to belong to them. The most grotesque shapes, the most inharmonious combinations of color, are honestly thought to be beautiful and "becoming," if only they are in vogue. For this reason, and because there is so much more of bad than of good in architecture, it cannot be expected that the good will be admired or appreciated. Absolute utilitarianism, an utter absence of all attempts at architectural effect (except in the rare cases where architectural considerations are paramount and the best can be achieved), would be infinitely better than the halting, blundering, ignorant productions that are neither good architecture, good engineering, or good sense. A Florentine once said to me, with real Italian enthusiasm: "I love the houses along the streets and their dear, familiar faces. When I go out for a morning walk, they seem to bow in kindly recognition and return my greeting as if they were really glad to see me." It would require a powerful imagination to fancy the fearfully and wonderfully designed façades in any American city possessing either the ability or the disposition to do anything but stupidly stare friends and foes out of countenance and complacently flaunt their own ugliness.

I know it is one thing to say these disagreeable things about everyday architecture, and quite another to make their truth apparent, be-

HIGH STREET, OXFORD, ENGLAND.

A PART OF FIFTH AVENUE, NEW YORK.

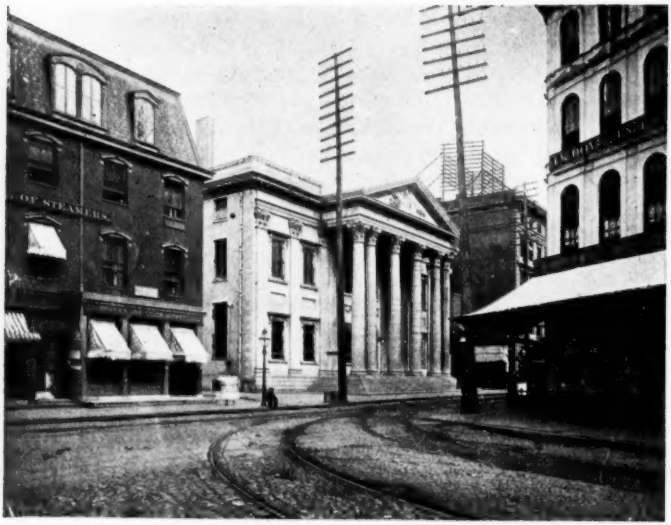
cause esthetic perception is a faculty of slow growth, and those who lack it most are usually the most abundantly satisfied with their own opinions. As an experimental test, compare half-a-dozen photographs of the average buildings along the principal streets of any of our cities with the same number of similar photographs of the best buildings in the world, architecturally considered,—buildings of similar size and intended for similar uses. There would be difference of opinion as to which are the best buildings in the world, as there would be concerning the greatest poets, musicians, or artists, but there will be no difficulty in finding work of whose intrinsic excellence there is no question. He who should be incapable of perceiving the superiority of the good in such a comparison (which would be no crime, of course; only a misfortune) would probably consider the hammering of an ill-bred child on the helpless keys of a piano just as agreeable as the magnificent chords of Handel's Largo.

It is useless to compare photographs or other pictures with actual buildings, because none but those who are familiar with the evolution of architectural design can form a correct idea of the appearance of a real building from a pictorial representation of it. (This common incapacity, by the way, gives opportunity for one of the most successful "tricks of the trade," especially in that part of it which is connected with competitions,—that is, the employment of a skilful artist to pre-

pare a colored perspective of the proposed edifice, and by that means captivate the committee, whose knowledge of good architectural design seldom goes beyond a juvenile admiration for a "pretty picture." This idealizing operation accounts for many disappointing decisions of building committees.) That photographs should be compared with photographs and line drawings with line drawings, and that perspectives, for purposes of comparison and competition, should be ruled out altogether, is a condition so obviously necessary for a just comparison that it would not need to be mentioned if it were not so constantly violated.

Another helpful experiment would be to find the best work in the city, and compare it studiously with the poor work around it. In this case, however, the good work is at a disadvantage for the reason above intimated; its rarity prevents recognition of its merit. Its message is virtually in an unknown tongue. And yet this is the only way in which popular education in this direction is achieved; slowly,—oh, how slowly!—involuntarily, and unconsciously.

Among the more conspicuous causes of the public obtuseness concerning architecture is the attitude, supposed to be necessary, of the local papers, which, in spite of so many protests to the contrary, do, to a large extent, direct the opinions of their readers in all matters that are outside of their personal interest or study. It is sufficiently



A CORNER IN PHILADELPHIA.

A GLIMPSE OF THE VIENNA STREETS.

unfortunate when the "art," "musical," or "literary" editor of a paper read by thousands who have no other opportunity for acquiring intelligent opinions informs his readers that worthless books, concerts, and pictures are worthy of the highest admiration, remarkable examples of our increasing culture and civilization. Yet the music may be forgotten in a week, the book may be laid away on the library shelves, and the picture left to blush unseen in some rarely-visited corner of the gallery. But a grievous and incurable harm is done when an esteemed and public-spirited fellow-citizen has the audacity to set up a seventeen-story block in defiance of physical, architectural, and moral law, and the public are assured, as by one having authority, that we have at last in our beautiful city "a monument of artistic grace" of which we ought to be proud. In similar false and fulsome phrase every new dwelling-house, whatever monstrous shape it may assume, however crude in color and form, however childish in composition, however grotesque and barbarous in detail, is described as a charming and unique addition to our varied and interesting domestic architecture, when there is not a visible quality about it that can be called architecture, unless the word is applicable to millinery, chidren's toys, and feminine bicycle costumes. Caprice is not architecture; exaggeration of necessary or useful features to the verge of absurdity is not architecture; novelty for the sake of novelty is not

architecture ; nor—let this be written large—do a few classic details, though copied directly from Vignola and indiscriminately applied to the outside of a building, make a "colonial" mansion of a broken-backed barn.

But to return to the papers and the lies they tell in the guise of architectural comment and criticism. Anything like public comprehension of good architecture seems hopeless while these shallow and essentially false comments are the only instruction ever offered to the people responsible for the style of our buildings. It would be obviously impracticable for an intelligent editor—and the more intelligent he is, the more difficult it would be—to say just what he thought of the buildings of his neighbors ; but it would seem to be possible for

BOULEVARD MONTMARTRE, PARIS.

him either to keep still, or to employ a competent critic to describe the merits of any building that possessed merits, and honestly commend the owner and architect, kindly ignoring what could not be wisely approved. Even this silence, which would soon be understood as tacit disapproval, might in the rough and ready regions cost an occasional subscriber, but it ought rather to strengthen a daily paper in communities where the arts are supposed to be fostered and appreciated. I refer to the daily papers in this connection because those who really desire to be well-informed have no difficulty in finding such instructions and information as they need in the various ably-conducted technical journals. But it is not those who desire to be instructed for whom instruction must be provided, but for the lost sheep

HOLBORN VIADUCT, LONDON.

who are unaware of their own ignorance, and to whom instruction must be given sugar-coated and in such form as to soothe rather than wound their self-complacency.

Aside from the objection to frank criticism that it might operate to injure the commercial value of private property, there is, in the

THE MANSION HOUSE AND CHEAPSIDE, LONDON.

case of religious and benevolent institutions, a sentiment that the purpose of the building lifts it above the possibility of adverse comment, even as to its outward form. Of course the most frequent illustrations of this are found in the nondescript churches which might easily be mistaken for country club-houses or extravagant stables. Shall we ever outgrow the notion that a shingled buttress gives an ecclesiastical expression to a wooden building that would be stronger and better without it? At best it is but a caricature, and caricature is the grossest form of irreverence. But wooden churches are not the only ones that stand on the wrong side of the narrow chasm between the sublime and the ridiculous.

LITTLE CHAMPLAIN STREET, QUEBEC.

Another common cause of the failure of our every-day architecture is the endeavor to combine incongruous uses in one building. The attempt to place Masonic Temples or Young Men's Christian Association rooms on the top of a commercial building and give to each its proper expression without transgressing all the known laws of construction and common sense cannot possibly result in anything else than an architectural hodge-podge. There should be as distinct a difference between a commercial building and one devoted to moral, religious, or philanthropic purposes as between a cooking-stove and a bedstead. Good architecture is not possible on any

WASHINGTON STREET AND OLD SOUTH CHURCH, BOSTON.

other basis. Far better to resign all attempts at architectural quality and make the building absolutely utilitarian.

The controlling influence of Mammon is perhaps as disastrous to all forms of art as it is to religion, and, while it is doubtless true that popular ignorance is more largely responsible for our architectural sins than professional incapacity, it is true in both cases that the mercenary influence is most disastrous. The architect must cater to the depraved taste of his client or lose the commission, and the owner

must build something that suits the depraved taste of the times, or he can neither command the highest rents or sell at the highest current price. Neither can afford to wait for the verdict of an enlightened posterity. Even admitting that all well-educated architects "in good and regular standing" are free from mercenary considerations, the important fact remains that a large portion of the "architecture" of the country is "done" by men who are *not* in good and regular standing,—who are simply manufacturers and dealers. They buy, borrow, steal, and, by the employment of more or less competent draughtsmen, manufacture, plans to suit what appears to be the popular demand. They have but one aim,—to sell their goods at a profit; but one standard of excellence,—immediate popular approval.

THE CAÑONS OF THE CANADIAN PACIFIC.

After all the foregoing condemnation, it is no paradox to say that, in the class of buildings referred to, we probably have some of the best modern architecture in the world, and in our great cities the buildings of the principal thoroughfares would appear to disprove the proportion of good and bad above insisted upon. It is also undoubtedly true that the best work is rarely found in any except the very large cities. Even in those, if the whole city (including the parts that are rarely familiar to any except the residents) is taken into the account as it should be, the ratio would hardly be changed. To say that there is nothing attractive in the appearance of very many of the

THE CAÑONS OF BROAD STREET, NEW YORK.

business thoroughfares in our cities large and small is quite another thing. In fact, the variety of color and form, of light and shade, and the life that animates them make nearly all streets, seen in perspective, attractive and picturesque. All the more so because the details of each building cannot be distinguished. The beauty of the street depends upon almost the same qualities that give charm to a deep rock-cutting for a railroad, and still greater to the narrow gorge or cañon of a river.

The high vertical walls, the broken surfaces of various colors, the play of light and shade, the combination of details in themselves unmeaning, all taken together and seen as a single picture, are full of interest and a kind of beauty. But a closer inspection, made face to face with any portion of the wall, reveals in the street crude, coarse, ungainly forms, without beauty of their own or harmony with their surroundings. While it is idle to compare any beauty of a work of art with natural beauty, nothing deserves the name of art which does not indicate refinement in its conception and trained skill in its execution.

We have a right to demand that the buildings along our streets shall be a succession of beautiful pictures, and, while there may be plausible, perhaps imperative, reasons for complete plainness, absolute barrenness of architectural effect, there is no excuse for positive ugliness.

GAS VERSUS ELECTRICITY FOR POWER TRANSMISSION.

By Nelson W. Perry.

THE development of electricity as a commercial factor has probably done more for engineering science indirectly than it has directly, great as have been the direct benefits. When we realize that in 1881 (when the Pearl street Edison Central station was first started), after the steam engine had received the best efforts of engineering science for scores of years, there was still no steam engine in the market perfect enough to give satisfactory performance in this new and exacting service, and that to-day there are scores of makes of engines that very fairly meet these demands, we see what the commercial development of electricity has done for the steam engine.

But it is rather of engineering science in the abstract that we speak. The mechanical and the civil engineer deal with forces of which they may have full knowledge, but the effect of these forces, when acting through the materials and under the conditions with which they have to deal, are not amenable to exact calculation. For instance, if they would prognosticate the result of the transmission of energy by means of fluids, they would assume as a basis a perfect fluid, and then modify the results by empirical factors known to be approximately correct only under special conditions, all of which can never be exactly known or fulfilled. The electrical engineer deals with an assumed perfect fluid, and needs no factors to bring his calculations within allowable limits of error. He therefore attacks a problem with more confidence than does the hydraulic engineer, for instance, and perhaps it is this very confidence in his ability to forecast results with certainty that has led him to neglect other engineering branches, and to believe that they cannot assist him in his work.

But in this scientific, utilitarian age we must not overlook any agency, however humble, that may assist in accomplishing our ends.

Gas engineering is an old profession as compared with electrical engineering, and it is not unreasonable to suppose that electrical engineering can profit by its experience. In fact, our present methods of electrical distribution are almost exact copies of practice long since recognized by the gas engineer, who, moreover, has solved one problem which we, as electrical engineers, have still to solve,—*viz.*, the cheap and efficient storage of our energy.

We have the storage battery, to be sure, which is getting cheaper

and more efficient every year, but it does not store the energy as does the gas-holder,—ready to be called upon at any time, and to respond equally efficiently to any rate of demand. Nor is it the ultimate solution, although, as will be shown, it is one of the most efficient methods known.

But the virtues and elasticity of the electrical system and the great simplification which it brings to engineering problems have blinded its votaries to the virtues of other methods of transmission.

To such an extent is this true that we find engineers of prominence signing their names to statements that energy can be economically transmitted electrically under existing conditions hundreds of miles, and the electrical press giving currency to these reports with editorial endorsement.

The facts are that the distances to which energy may thus be economically transmitted are limited by the original cost of the primal energy, the cost of energy with which it must locally compete after transmission, and the voltage against which it is commercially possible to insulate To simplify this statement, if we assume the first two factors to remain the same, then the distance is strictly limited by the voltages practicable.

In discussing the distribution of power over more limited distances, however, as in large cities, we are not hampered by the upper limits of practical voltage, but by other conditions,—*viz.*, the voltages at which the energy must be used in our electric lights, in our motors, and in other ways.

In these shorter transmissions, as in the longer, we find the electrical method by no means the most economical, although for general purposes of distribution and subdivision of power it is supreme.

It may be laid down as an axiom that for transmission purposes the energy should be in the potential form, and for distribution and subdivision in the kinetic.

This is clearly proven by the fact that we are transmitting coal for hundreds of miles at a cost that renders its use economical, whereas, if we assume 20,000 volts as a practicable potential to use, we cannot transmit energy electrically over perhaps thirty miles at the outside so as to compete with coal carried the same distance.

The actual cost of coal transportation by railroad is given at about half a cent per ton-mile. If we measure our tons as 2,000 pounds instead of 2,240,—allowing the 240 pounds extra of the long ton to cover losses in transit and other small incidental expenses,—and allow 5 pounds of coal to the horse-power hour (and this is liberal), our ton of coal represents to us 400 h.p. hours, and its transmission has cost us 5 mills, or .00125 cents per h.p. hour transmitted.

In our low-potential lighting systems the most advantageous arrangement possible at present, for short distances, is the three-wire system with 220 volts between the outside wires, and the limit to which distribution by this means is found economical is about one mile. In allowing a loss of 240 pounds of coal in transportation for every ton, we have allowed about ten per cent. loss. This is also the usual loss allowed for transmission electrically, where the same distance is involved. The copper required for this purpose would weigh 332 pounds and cost not far from $106, if of insulated wire, and the interest on this at six per cent. would be $6.36.

Our most favorably situated electric-lighting stations do not average more than forty per cent. of their maximum output; hence $8,760 \times .40 = 3,500$ h.p. hours would have to bear the charge of $6.36 interest, or .182 cent per h.p. hour as against .00125 per h.p. hour transmitted in the potential form of coal. Or, in other words, it would cost more than 145 times as much under the conditions named to transmit energy electrically to a distance of one mile as it would to transmit it in the potential form of coal.

But we have assumed, for comparison, conditions very favorable to electricity, or, rather, very unfavorable to coal; for we have assumed it to be transported by steam, and, in converting it into the kinetic form, we have assumed nothing for the handling or second transportation to the central station, which may not be on or near a railroad.

Usually central electrical stations are placed, as the name implies in localities central to the largest demand for the output, and this more often is on expensive land removed from the railroad. A second charge is, therefore, placed on the fuel by its additional handling and transportation from the railroad or water front to the point of consumption, and this second charge usually exceeds the railroad charges, even where long rail transportation is involved. As an illustration, the cartage of coal to the Duane street New York Edison Illuminating station costs that company 45 cents per ton, and the handling of the ashes an additional 9 cents, making a total of 54 cents per ton above what the fuel would cost were the station located on the water front. Yet it has been found more economical to locate in the center of their areas of supply with the expensive ground and water rents and these additional burdens on fuel account than to locate more advantageously in these respects and incur the increased transmission losses by electricity involved in that otherwise more advantageous location.

But there are other methods of transmission of energy in the potential form even more economical than that by rail, examples of which we see in the distribution of gas and oil in pipes.

Where gas is transmitted for illuminating purposes, it is in one sense a transmission of energy in the kinetic form, just as is our water, if used for turning a water motor, but, if it be transmitted to be burned in a gas engine, which in turn is to drive a dynamo for lighting purposes, it forms an illustration again of the distribution of energy in the potential form; and, by comparing the amounts of light obtainable from a given quantity of gas used in these two ways, we again see the economy of the potential over the kinetic distribution, notwithstanding the numerous transformations involved before the potential energy of our gas takes the form of light.

Thus it is easily proved theoretically that, with our ordinary 16-candle power illuminating gas, only about one-third as much light can be obtained by burning it directly in ordinary burners as can be obtained by burning it in a gas engine and then, through the agency of the dynamo, converting it into light; the writer has seen a number of cases where, under not the most favorable conditions, fully twice as much light was thus obtained as could have been by direct consumption in the gas-burner.

In municipalities, in particular, the question of cheap distribution of power becomes of the utmost importance, and is now demanding the attention of the best engineering talent in the world. It is not enough that, when the power is delivered, it should be cheap, but it is essential that it shall be available,—that is, that it shall be in such a shape that it can be utilized with the least inconvenience for the largest variety of purposes

There is no question to day that, when energy is delivered in the electrical form, it realizes the latter conditions more nearly than they can be realized in any other way; but I have rather postulated that the electrical means of transmission is not the best at hand.

If it costs the largest electric lighting station in the United States 54 cents to bring to the sidewalk in front of its boiler-room a ton of coal which it has cost but half a cent a mile to deliver at the water front, not over two miles away, the question naturally arises: why does not the Edison Illuminating Company locate its central station on the water front, and save that 54 cents, and there convert the coal into electricity and distribute it to its customers in that form? I cite the New York Edison Illuminating Company as an example, for the reason that it is the largest station in the country, one of the most progressive, and an illustration of the practice of all the economies that engineering science has thus far endorsed. So that what I may say in regard to it is not by way of disparagement of its efficient management, but by way of emphasis of certain engineering facts which I hope to bring out. It will serve my purposes best because it stands

to-day as an illustration of perhaps the best type of central-station practice in the world.

With this understanding, let us see under what disadvantages it labors.

In the first place, its various stations are located where they can reach the largest number of customers within the shortest possible distance. This means, of course, where real estate is exceedingly expensive and where interest on investment is correspondingly high. It happens in this case, as in the case of most electric-lighting stations, that this location is not favorable to cheap coal. We have seen that, by reason of the location, it is paying 54 cents more a ton for its fuel than it would have to pay were it located at the depot of supplies. It pays this penalty on some fifty thousand tons of coal per annum, which amounts to the sum of $27,000 and is equivalent to the interest at six per cent. on $450,000. This is in addition to the interest on the difference between the cost of real estate in the central portions of the city and that of property along the water front, which would cost less than half as much.

Water costs to the largest consumers in New York 10 cents per 100 cubic feet. In practice we may say that the relative amounts of water consumed by condensing and non-condensing engines, irrespective of the water used for condensing, is about as 3 to 4; but, with water at 10 cents per 100 cubic feet, the use of condensing engines is commercially impossible. If the station were located on the water front, water for condensation purposes would cost practically nothing, and the saving in the water bills for steam purposes would be more than 25 per cent. This use of condensing engines would mean a saving of fuel of anywhere from 15 to 25 or more per cent., and thus one economy would render others possible.

The question naturally arises: if these statements are approximately true, why does the New York Edison Illuminating Co., why do not other electric-lighting companies in our larger cities, move a couple of miles from their present locations, so as to enjoy these economies?

The answer is simply this: that to do this they would incur, by reason of the additional distances to which they would have to transmit current, so largely increased expenses as to more than compensate for the advantages attained. That is to say, the cost of transmission over the additional distance would more than balance the savings effected, large as they would be, by the change of location.

The layman might argue that they are handicapped by the low voltage to which they are limited, and that, could they transmit at higher voltages, these disadvantages of distance would disappear.

The electrician might say: "I can transmit your current at higher voltages, and reduce it at the distributing center by storage batteries, motor generators, or static transformers"; yet this is not done. The reason is that conservative engineers have not been convinced that even these resources would prove more economical than present practice, and, with the great certainty with which electrical calculations are verified in practice, it is not probable that their conclusions are materially wrong. Hence we must conclude that neither the coal cart or electrical means satisfactorily solves the question of local transmission.

I use the term "local transmission" in a very different sense from the term "local distribution"; while I believe that the electrical method is by far the best known for local distribution, it seems for local transmission not yet equal to the coal cart. For distribution purposes, however, the coal cart, while still more largely employed, must give way to electricity.

Omitting for the present the cheaper methods of getting our energy to the centers of distribution, let us consider the requisites for its cheapest conversion at that point into the kinetic form.

Reference has already been made to the large tax upon the cost of power in the form of the fixed charges due to high rentals. These should be lessened, if possible, by using less space. That is to say, our apparatus for the conversion from the potential into the kinetic form should be as compact as possible, and this apparatus should be used as nearly continuously as the demands of the service will permit, and, while idle, should be no greater charge on the cost of power than the interest on the investment.

Evidently, driving dynamos by steam engines does not answer either condition, and the situation is made still worse by the small proportion of the total capacity of the plant required of any machinery erected for commercial distribution of power at the present day.

In this country there are few central stations whose average supply is as high as forty per cent. of their maximum capacity, and in England and on the continent probably none. Therefore these interest charges on the expensive real estate and conversion charges are, if we assume a load factor of forty per cent., two and a half times what they would be if only sufficient apparatus were installed to supply the same aggregate demand continuously used. Thus, if we allow six per cent. interest on the investment as it is made to-day, it is equivalent to fifteen per cent. on that which would be adequate if the investment were utilized to the best advantage.

Very much the same may be said of the insurance, labor, and administration charges, for these remain practically constant, whether

the apparatus is employed to its fullest capacity or to only forty per cent. of it. These sources of expense can only partially be avoided, because we cannot regulate the demands. As purveyors of power we must meet the demands as they exist, in the best way that we can, but there is usually another source of expense in the production of power which is quite as serious as any of those mentioned, and which should be more easily dealt with,—*viz.*, the stand-by losses of our steam machinery. When the latter is idle, it is not only the insurance, taxes, and interest charges that continue, but also a large portion of the fuel and labor charges.

It has been estimated by very competent authority that the stand-by losses of the boilers in an English electric-light station—*viz.*, the amount of coal they consume while banked during light load —amounts to ten per cent. of the total coal consumed in the station.

While it is a fact that in most industries the total cost of power does not constitute more than 10 per cent. of the cost of the finished product, we must remember that in this particular industry—the power industry—it constitutes 100 per cent. of the cost of the finished product. Every item of expense, therefore, must be far more closely scrutinized than it would be under other conditions.

To illustrate the combined effects of the above sources of expense I have given elsewhere* the estimated cost of power under present methods, but with steady load, as $48.68 per horse power per year with coal at $1.75 per ton, and $65.62 per year with coal at $3.50 per ton, whereas, under the same conditions, except that the load factor was assumed to be twenty-five instead of one hundred per cent., it would be $117.78 with coal at $1.75, and $148.40 at $3.50.

The most obvious method of overcoming these losses, and the one most advocated at present, is the conversion of the energy immediately upon generation, or at some subsequent stage, into the potential form,—*viz.*, storing it up during light demand for use at times of excessive demand, thus equalizing the load on the generating plant, so that the latter may be employed continuously to its full capacity.

As showing the effect of storage at the successive stages of the generation of electrical power, I quote from the same paper as follows:

The saving by introducing storage		Cost of horse power at this stage.
between boiler and engine is	$30.69	$ 48.68
" engine and dynamo	23.56	87.09
" dynamo and distribution	14.85	117.78

That is to say, if the storage cost nothing, the saving at those

* "The Storage of Energy Essential to Economy of Working in Central Stations." A paper read before the National Electric Light Association, February 20, 1895.

stages would amount to the sums mentioned under the conditions assumed. But storage cannot be obtained for nothing, and it therefore becomes necessary to consider the expense and the efficiencies of the various methods of storage of energy most in use.

It is evident that in many situations the space and weight efficiency of the storage may become quite as important as the conversional efficiency, and for this reason the following comparison is given:

According to the latest catalogue, the largest storage battery listed weighs 3,970 pounds complete, occupies 7 cubic feet of space, and has a storage capacity of 25.7 h. p. hours under normal discharge, or 19.3 h. p. hours under rapid discharge. According to Mr. A. E. Childs,* such a cell can be installed complete for about $30 per h. p. capacity. If discharged in 3 hours, the h. p. capacity of such a cell is about 6 h. p. Its space efficiency is, therefore, a little less than 3 h. p. hours per cubic foot, and its weight efficiency 16½ pounds per h. p. hour at normal discharge.

In Halpin's thermal storage, working under 265 pounds pressure, which corresponds to a temperature of 406° F., 4.06 cubic feet for condensing engines and 6.4 cubic feet for non-condensing engines are required per effective mechanical h. p. hour, which, assuming a dynamo efficiency of 90 per cent., becomes 4.5 cubic feet for the former and 7 cubic feet for the latter.

In water storage, if the elevation were 100 feet, 317 cubic feet would be required per h. p. mechanical, or 352 cubic feet per electrical, h. p. hour.

In gas storage, if we assume 16-c. p. illuminating gas, 20 to 25 cubic feet capacity are required, and, with Dowson fuel gas, from 75 to 100 cubic feet.

All of these methods, except water and gas storage, involve material losses in storage, either frictional or conversional, and all except gas storage involve transmission in the kinetic form, or else by the coal cart, which, as has been pointed out, is expensive. All, except gas and water, involve also the use of boilers, and these involve real estate and stand-by losses.

In our most compact central stations the floor space is about equally divided between the boiler room and the engine and dynamo room. To do away with the boiler room would, therefore, effect an economy that is exceedingly important where real estate is high and where the load varies as it does in electric light and power stations.

It is clear that, if we could convert our coal into a gaseous fuel at

* "Discussion of Storage-Battery Applications." *Trans. Am. Inst. E. E.*, November 20, 1895.

the water front or railroad line, and transmit it in its prepared state to gas engines located at centers of distribution, we could save half of our floor area, and avoid the stand-by and condensation losses, etc., of our boiler plants, for the stand-by would then be our gas main, which, if it did not leak, would cause no losses while the engines were idle, and involve no extra expenditure of fuel corresponding to that required in getting up steam and in the drawing of fires.

The late Mr. Denny Lane, who was a gas engineer of prominence, stated before the Institution of Civil Engineers that "with ordinary town gas of 16 candle power, 3,000 h. p. could be sent a distance of 1 mile for an expenditure of 1 h. p.,—an economy of distribution far exceeding that possessed by any other system, either hydraulic, pneumatic, or electric, being only $\frac{1}{30}$ per cent. of the power conveyed."

To carry this line of argument a little further, I have assumed, first, that we wish to transmit our gas through a 12-inch pipe to a distance of 5,000 yards, or nearly three miles. It is assumed that this gas has a specific gravity of .55 as compared with air, and that its calorific power is such that, when burned in a gas engine under fair conditions, it will require 25 cubic feet to produce 1 h. p. hour.

These figures, carried out for pressures varying from 1 inch of water to 10 inches of water, are given in Table I, and show that, with 1 inch of water, 500 h. p. can be delivered through a 12-inch pipe having 25 90°-bends to a distance of 5,000 yards with an expenditure of but $\frac{7}{1000}$ of 1 per cent. of the energy transmitted, and that, with a pressure of 10 inches of water, 1,600 h. p. can be delivered with an expenditure of $\frac{7}{100}$ per cent. of the energy delivered.

TABLE I.

TRANSMISSION OF GAS .55 SP. GR., 5,000 YDS., THROUGH 12-INCH PIPE WITH 90°-BENDS EVERY 200 YDS., WITH VARIOUS INITIAL PRESSURES.

Inches Water Pressure.	Cu. ft. delivered	Velocity of Flow in ft. per second.	Increase of pressure for each 90°-bend in pipe.	Total increase pressure for 25 bends.	Total Initial Pressure in Inches Required to Deliver Gas.	H. P. Delivered 25 cu ft. 1 h.p.h.	Ft. lbs. per sec. consumed in transmission.	Per cent. of Power Transmitted Consumed in Transmission.
1 inch	12,500	4 ft.	.0016 in.	.04 in.	1.04 in.	500	17.3	.007
2 "	18,000	6 "	.0034 "	.085 "	2.085 "	720	51.5	.013
3 "	23,000	8 "	.006 "	.1495 "	3.15 "	920	105.12	.0208
4 "	25,500	8.8 "	.0076 "	.189 "	4.189 "	1020	151.5	.027
5 "	28,000	9.6 "	.0086 "	.215 "	5.215 "	1120	204.7	.033
6 "	32,000	11. "	.0113 "	.28 "	6.28 "	1280	284.	.04
7 "	34,000	12. "	.0135 "	.34 "	7.34 "	1360	359.	.048
8 "	36,000	12.5 "	.0147 "	.39 "	8.39 "	1440	430.	.054
9 "	38,500	13. "	.0158 "	.4 "	9.4 "	1540	501.	.06
10 "	40,000	14. "	.0183 "	.46 "	10.46 "	1600	602.	.07

Cast-iron pipe 12 inches in diameter and ¾ of an inch thick weighs about 300 pounds per yard, and the total length of 5,000 yards would, therefore, weigh about 800 tons. This can be bought in the open market to day for $20 per ton,—an investment of $16,000.

If we should endeavor to deliver this same amount of energy electrically at 10,000 volts, with the same efficiency of transmission, it would require twenty-eight 0000 B. & S. wires, and these would weigh 538,020 pounds. If we charge nothing for insulation, and put the cost of bare copper down to the ridiculously low figure of 12 cents per pound, we have an investment of $64,562, or four times that for the gas mains. As a matter of fact, even granting such concessions as I have made to the electrical method, there is another and all-important element which cannot be ignored,—*viz.*, that we have no way of using the electrical current at anything like 10,000 volts. To make it available, it must be transformed down to at least something like the voltages now in use, and this means additional losses in energy and additional invested capital. If we should admit that it is practicable to generate the direct current at 10,000 volts, then the storage battery or motor generator would be available; but the highest efficiencies claimed for either of these admits a loss of several per cent.; so that, even if the electrical transmission were of 100 per cent. efficiency, the losses in rendering the current available by stepping down the voltage would be several hundred per cent. greater than the highest losses given in Table I for gas transmission.

With the alternating current very much higher voltages might be used, if suitable insulation could be procured, and thus the efficiency of transmission increased over that claimed for gas, and the cost of copper correspondingly decreased; but the transformation problem still obtrudes itself, and the ultimate efficiency would still be several per cent. less than that claimed for gas: so that it may be said that it is not theoretically possible to transmit energy electrically in municipalities as efficiently or as cheaply as it is actually accomplished to-day by gas.

These statements apply, however, only to comparatively short distances, for it will be seen, by reference to Table I, that the efficiency of gas transmission varies inversely as the pressure. With electricity, however, the efficiency increases directly as the pressure, so that a point will be reached where the two curves cross each other and the relative conditions are reversed.

(*To be continued.*)

PAVEMENT CONSTRUCTION AND CITY GROWTH.

By Stevenson Towle.

THE health, wealth, and comfort of a city depend in a large degree upon the character of its pavements.

The ancients appreciated more fully than we the value of well-paved roads, and the building of these roads immediately followed every conquest; this was deemed necessary in order to fully develop the resources of the country and bring to the government the greatest possible revenue. The Roman domain was extended more for revenue and profit than for glory; good roads and their maintenance were considered essential to this. So thoroughly and well were these roads built that many of them are in use to this day, especially in Spain and in the far East.

Merchants and business men have come to realize that their ability to do business and compete with other cities depends on the ease and cheapness with which goods can be carted and handled in transit through a city. Good pavements mean increased profits; heavier and larger loads can be handled with advantage. It was not until about thirty years ago that the great commercial cities of Europe first became convinced that their welfare depended on their having suitable pavements. They immediately began to construct substantial pavements, on a comprehensive plan. London, Liverpool, Paris, and Berlin have spent vast sums for this purpose, and have found these expenditures a most profitable investment, the improved pavements enabling their merchants and manufacturers, by the lessening in the cost of hauling and handling goods within the city limits, to control the markets of the world. The most substantial pavements were laid, and the cost was not considered. These cities also realized the fact that their interests were harmonious with those of the great railroads and steamship companies having their terminals within the city, and that therefore depots, wharves, and warehouses should be connected by well-paved streets. While these improvements were being made abroad, the merchants of this country were losing vast sums of money in trade, due in a great measure to the extra cost they were compelled to bear by reason of the cost of carting goods over bad pavements. New York, in particular, was a sufferer, being the great *entrepot* for foreign and domestic commerce. Merchants were discouraged in their efforts to compete with foreign cities.

In Europe the national governments exercise paternal care over cities, and direct the improvements to be made. In this country the conditions are different; the municipal government cannot make important improvements without obtaining the sanction of the State legislature. This body is not always open to conviction, and the legislature of New York has been no exception. It was with the greatest difficulty that it could be made to see the vital necessity of improving the pavements of this city, and to realize the great loss and injury that our merchants were sustaining by reason of their neglect. It was only by the efforts of the chamber of commerce and of Mayor Hewitt and his engineer expert, who had recently examined the best pavements of Europe, that the legislature was prevailed upon in 1889 to allow the city to expend $1,000,000 annually in improving its pavements. The fruits of this liberality are everywhere apparent; merchants and manufacturers immediately felt the advantage; great manufacturing concerns found it to their interest to retain their business in the city. The experience of New York in its efforts to have better pavements is similar to that of other cities, at home and abroad, and a short statement of the conditions that prevailed and the improvements that have so far been made may be of service.

Originally the pavements were mostly of cobble stones; afterwards of Belgian blocks, and sometimes of granite blocks on a sand foundation. The pleasure-drives or boulevards were paved with macadam pavement. The old cobble stones and Belgian blocks were utterly inadequate for commercial traffic, and were soon completely destroyed. Various kinds of pavement were tried. The first was the Russ patent pavement, laid on Broadway in 1849 (about 2½ miles in length). It was the most substantial pavement that could be devised, formed of syenite blocks twelve inches wide and about the same in depth, laid in diagonal courses on a substantial concrete foundation. This pavement was not satisfactory, owing to its slipperiness, the blocks being wide and the joints close, thus affording no foothold for horses. No more of this pavement was laid. The next trial was that of the Belgian-block pavement, first introduced and laid in this country in 1852. It was made of small trap blocks quarried from the palisades, and laid on a sand foundation. It was a very satisfactory pavement for a short time; it was durable and easily cleaned, and such an improvement on the old cobble-stone pavement that the latter was soon almost entirely replaced by it. In a few years this pavement was extensively laid throughout the city, especially in the business parts. The merchants and carters naturally took advantage of this smoothness and the ease with which heavy loads could be drawn on the new streets, and increased the weight of loads to as much as the horses

could draw. The weight of these loads in many instances was much more than the pavements could bear, and as a result this comparatively satisfactory pavement was soon destroyed, and a stronger pavement had to be provided. To this end the old Russ pavement on Broadway, although still intact, was replaced by the improved granite pavement, similar to the improved pavement being laid in London. Unfortunately for the city, the contractor had procured a patent for it, and the pavement could not be used by the city, for the reason that all patent pavements were prohibited by law. Finally the patent was invalidated, and in 1882 the city resumed the laying of this pavement on several busy thoroughfares. Its great cost, however, due to the expense of quarrying and making the blocks, precluded its general use. It was thought to lessen the cost by omitting the concrete foundation, and for several years pavements were laid in that way. This cheapened pavement was a great improvement on the old Belgian pavement, and was capable of sustaining heavier loads; and for a short time it seemed to meet the requirements of commerce. But it wore out under the increased loads, for lack of proper foundation. Fortunately, the introduction of improved machinery and scientific methods in the quarrying of the blocks had so far reduced their cost that the pavement could be laid on a substantial foundation at a price less than that first paid for the pavement without the concrete base. It was this cheapening of the cost of granite pavements and the absolute necessity of the concrete base that induced the legislature to authorize the new pavement. In determining the kind of pavement best suited to the different traffic, the experience furnished by the cities of London, Paris, and Berlin was a great aid. In making the selection, business needs were first considered; then the residential sections, where old, worn-out Belgian pavements prevailed; then the tenement district; and lastly the pleasure-drives. Cobble-stone and Belgian-block pavements will not be considered here, as they are not first-class pavements.

Brick pavements are not an experiment, having been laid for the past two hundred years in Holland, where many of them are in a satisfactory condition to this day. They are now being extensively laid in many of the cities in our western States, where they prove themselves suitable for moderate traffic. The sample block laid in New York is wearing satisfactorily, and has had little or no repairs since laid five years ago. They are less noisy than stone, and afford easy traction for horses, and, when laid with cemented joints (grouted), absorb but little rain-fall. They are to be preferred, where the traffic is light, to macadam or stone. Great care should be taken in selecting a brick of proper quality. The hardness is no test of suitable-

ness for a pavement, for some of the hardest brick do not wear well. Many failures of brick pavements in this country were due to defective foundation, and to the fact that bricks were used which were obtained from local sources, because they were cheap, and in order to foster the home industry. The bricks should be hard and well burnt throughout, of uniform size and compact construction, capable of bearing the usual test considered necessary and sufficient for this kind of pavement. First, they should sustain a pressure of 13,000 pounds to the square inch. Second, they should not be reduced more than 3 per cent. in weight by abrasion. Third, they should not absorb more than 2½ per cent. of water in twenty-four hours. Tests should be made, not only before accepting a particular quality of brick, but frequently during the laying. The best practice is to lay the work on a concrete foundation from four to six inches thick, according to the traffic. A bed of fine sand from ½ to 1 inch in thickness should intervene between the concrete and the brick. It is the practice with some engineers, where travel is heavy, not to use the sand bed, but to lay the bricks directly on a bed of hydraulic cement mortar. There is considerable difference in opinion, however, as to whether a pavement so laid is as durable as one laid on a simple bed of sand. The brick should be laid with very close joints in courses at right angles to the curb lines, and at street intersections in diagonal courses. Adjoining railroad tracks, it is found better to lay one row of stone blocks to receive the extra travel at this point. The brick being laid and the course accurately adjusted to the true line, the joints of the pavement are filled either with very fine hot sand, for ordinary traffic, or with Portland-cement grout for ordinary and heavy traffic. In order to secure the best material and workmanship, it is absolutely essential to have the contractor guarantee his work for at least five years; for even the most frequent and accurate tests and careful selections do not insure an absolutely uniform texture of brick; the test of actual wear is the only reliable one.

Granite pavements laid on concrete foundations, similar to those of London, Liverpool, and Manchester, are most durable for business purposes, and have been adopted for use in New York. The pavement is laid on a foundation of six inches of concrete with granite blocks 3½ to 4 inches in width, 7 to 8 inches in depth, and 8 to 10 inches in length. These dimensions conform to the London specifications, except that greater variations in the depth of the block were allowed in the American pavement. While this greater variation lessens cost, it is not economical, as it causes the surface of the pavement to wear unevenly, the shallower blocks sinking below the deeper ones. The inequality of the under side of the pavement soon becomes

transferred to the surface, producing a roughness and inequality that destroy the pavement and render haulage difficult and expensive. There have been so many improvements in the methods of getting out paving blocks and quarrying and preparing them, and the price has been so greatly reduced, that there is no longer a reason to use blocks varying in depth. In laying a first-class granite pavement, the carriage-way is excavated for the required depth to receive the foundation, and made compact by ramming and rolling. All unsuitable material not insuring a firm foundation should be removed and replaced by proper material. On this bed the concrete foundation should be laid ; it should have a depth of 6 to 8 inches, according to the weight of traffic. The American Portland cement is to be preferred as stronger and costing no more than the natural cements. The concrete should be allowed to set for three days before laying the pavement. A layer of fine sand is spread upon the foundation to a sufficient depth to bring the pavement to a proper grade. The blocks are then laid in the course at right angles to the curbs, except at street intersections, where the courses are laid diagonally, in order to provide for the cross travel. The blocks are rammed to near the finished grade, hot paving gravel is poured into the joints, the blocks are again rammed to grade, and the courses aligned. Hot paving cement is then poured into the joints until they are filled. The best paving mixture, one that resists the heat of summer and the frosts of winter, is three parts of coal tar with one of asphaltum. Great care should be taken to pour the paving cement while boiling. Gravel is then spread over the cemented joint to absorb any excess of paving cement.

The great success of the asphalt pavements now being laid in this country proves that they are well suited for residential streets, and likewise for streets having the heaviest traffic. They are particularly adapted for business streets on account of the facility with which the pavements can be restored. The objections of the carters have entirely disappeared, for they find that much heavier loads can be carted, with greater safety. The advantage on the score of cost is now very much in favor of asphalt ; this is due to the great improvements in the pavement. An asphalt pavement can be laid so as to require little or no repairs for five or six years, or even fifteen years. This is due to competition and improvements in the machinery for mixing and laying the pavement, and to experience obtained in compounding and laying it, and also to the knowledge that the cost of maintenance is much less than was previously estimated.

The comparative durability of the asphalt pavement is clearly shown on many business streets. The pavement, to be successful, must be composed of the best substances, mixed and laid in the best

manner, with improved machinery and scientific methods. The failure of many of the asphalt pavements is due to not using proper asphalt. It is the experience of New York that the best asphalt pavements are laid with the Trinidad Pitch Lake Asphalt, Alcatraz from California, and Bermudez from Venezuela, the Sicilian mines at Ragusa and ver Wohle, and the Swiss mines of Val de Travers. Ordinarily the pavement is laid on a concrete foundation, although those that have been laid on the old stone pavement or on macadam pavement have proved equally durable. The durability of the pavement depends on the asphaltum, and the greatest care should be used in selecting it.

When pavements are of Trinidad, Alcatraz, or Bermudez asphalt, the wearing surface is composed of refined asphaltum, heavy petroleum oil or fluid natural bitumen, fine sand, and powdered carbonate of lime. The asphaltic cement must be composed of 100 parts of pure asphalt, and from 15 to 20 parts of residuum or natural bituminous oil. In compounding the pavement, from 12 to 15 per cent. of this cement is mixed with from 70 to 83 per cent. of sand, according to the fineness and quality, and from 5 to 15 per cent. of pulverized carbonate of lime, as may be necessary; the pulverized carbonate of lime may be omitted when the quality of the sand warrants it. The sand is heated to about 300 degrees F., and the carbonate of lime is then added in the required proportions; the asphaltic cement is heated to a temperature of 300 degrees F., and then mixed with the hot sand, care being taken that the temperature is nearly uniform for both.

The paving mixture, when it reaches the ground or work where it is to be used, should have a temperature of not less than 250 degrees F.; this heat can be maintained during a transit of 1½ hours. As soon as the mixture reaches the work, it must be spread evenly to such depth that, when ultimately compressed, it will have a thickness of from 1½ to 2½ inches, as may be required. The first compression, which is a light one, should be done by hand rollers, and the final compression by a steam roller weighing not less than 250 pounds to the inch-run. This rolling should continue for not less than five hours for every thousand square yards of surface. It is found advisable to reinforce the asphalt pavement along the gutters for about one foot in width, by spreading and saturating the pavement with pure hot asphalt, which should then be thoroughly ironed. This prevents the decay of the pavement due to the lodging of water.

Where the pavement is composed of natural lime stone rock, the manufacture is very different; the rock must be finely crushed and pulverized; too great care cannot be taken at this stage of the process. The powder is then finely screened. It is generally necessary to mix different kinds of asphaltic rock in order to get the proper pro-

portions of asphalt. Some of the rock asphalts are rich in bitumen while others are lacking therein ; the proper proportion of each gives the desired mixture. This mixing is always done before the rock is ground. The powder, when mixed, should contain from 9 to 12 per cent. of bitumen and from 80 to 91 per cent. of the pure carbonate of lime ; the mixture must be absolutely free from quartz, sulphates, iron pyrites, or alumina. It is advisable to make the thickness 2½ inches, so as to allow of gradual compression under actual wear ; it is impossible to compress the asphalt when first laid, and its ultimate or final compression can be had only by actual traffic.

Macadam pavements are not recommended for cities, and should not be laid except for pleasure-drives ; when laid, they should be of the very best material and workmanship. None but the hardest stones should be used ; particular care must be taken in the preparation of the foundation and in selecting the very hardest stone for the top or wearing surface,—preferably trap rock, syenite, or granite, in the order named. The foundation should be what is known as Telford foundation. For light pleasure-drives a foundation of six inches of broken stone may be substituted for the Telford, but it is found more costly in the end. The course of broken stone following the Telford may be of the same material as Telford, but trap rock, syenite, granite, or lime stone is preferred. The stone may vary from 2 to 4 inches in diameter. This course should be evenly spread and only lightly rolled, without watering, and the surface should be left uneven to bond the next or wearing course, which should be of the hardest rock obtainable, should vary but little from 2 inches in diameter, and should be as nearly cubical as possible. The binding material for the course and top dressing should be of screenings and the same rock, as near ½-inch in size as possible,—free too from dust and dirt. The course should be regularly and compactly rolled with a roller weighing at least 10 tons, and sufficient water should be used to thoroughly saturate and wash the screenings into the voids and interstices of the broken stone ; the screenings should be rolled, until the surface is even and unyielding. On grades of over 1 per cent. it is advisable to pave the gutters ; the stones are best laid in courses, at right angles to the curb.

Some twenty thousand square yards of asphalt block pavement has been laid in New York within the past five years, and proved well adapted for light traffic. It is very much smoother and less noisy than any of the stone or brick pavements. So close are its joints that, under the influence of heat and traffic, the blocks become cemented together, forming almost a water proof pavement. There has been a great improvement in the manufacture of these blocks, tending to make them more durable. They are now made with broken trap

rock, instead of the soft lime stone rock previously used. Adjoining railroad tracks, asphalt blocks not being suitable, it is advisable to use a row of stone blocks. It is claimed that this pavement is less slippery than sheet asphalt; this may be so to a limited extent, but not generally, excepting on steep grades, for the pavement that has recently been laid, with particularly close joints, is almost as smooth as the sheet asphalt. It has this advantage: it can be laid remote from the factory and by ordinary pavers, not requiring the skill and machinery necessary for sheet-asphalt pavements. The blocks are of uniform size,—in width 4 inches, in depth 4 inches, and in length 12 inches. The best practice is to lay the pavement on a foundation of concrete from 4 to 6 inches in thickness. Upon this foundation is spread a layer of fine sharp sand ½ inch in thickness to serve as a cushion. The blocks are laid in courses at right angles to the curbs, and, at street intersections diagonal thereto, the block should be broken by the lap of four inches. After about twenty courses of brick have been laid, the courses should be adjusted to an exact line. The blocks should then be rammed to an unyielding bed, and the surface made perfectly true and uniform and properly graded. When the ramming is completed, a layer of fine dry sand should be spread freely over the surface and swept into the joints. For light traffic, and where it is necessary to save expense, the concrete foundation can be omitted; this is generally the practice outside of New York.

The failure of wood pavement in this country did not prevent its extensive use in London and Paris, where its success was due to excellence of construction and maintenance, involving a cost at least double that of the best asphalt or stone pavement; in those cities cost is not considered. A noiseless comfortable pavement is insisted on, no matter what the expense; and wood in this respect has been most satisfactory.

A substantial concrete foundation is necessary to this pavement. Six inches in thickness is considered ample, although in rare instances the London pavements have been laid on eight inches of concrete. The best European practice is to use blocks not treated with chemicals to prevent their decay; all chemical processes have been abandoned, except that of impregnation with the oil of creosote. There is now being used in London a wood from Australia entitled the Karri wood. This wood is compact and very solid, and, it is claimed, more lasting than the ordinary spruces, pines, and other woods used for pavement, even when treated with creosote or by any of the chemical preserving processes. This wood is extremely hard and compact, but makes one of the slipperiest of wood pavements. A sample was laid in Twentieth street, New York, about a year ago, following the English specifications.

The comparative slipperiness of the different kinds of pavements is now definitely known from actual observation. The tables, observations, and conclusions of European authorities are not applicable to this country, where the conditions are different,—not only the climate and the characteristics of the pavement, but the manner of shoeing the horses. In Europe granite pavements are laid with a smooth surface and very close joints, and consequently are more slippery than the granite pavements in this country, where the joints are open, smooth surface and close joints affording the smoothly-shod horse less foothold. The rock asphalt used in Europe is free from grit, polishes very smooth, and becomes extremely slippery, while the Trinidad or California asphalt used in this country, being composed principally of sharp sand, affords a gritty surface and is less slippery. In this country the opportunity of observing the comparative slipperiness of wood pavements is very limited; but experiments in Europe show them to be extremely slippery at times,—more so than stone or asphalt, especially when there is a slight frost.

The cost of all kinds of pavement has been greatly reduced within the past few years, owing principally to competition and improved methods of quarrying and cutting the stone blocks. Asphalt is now mined, and loaded directly into the vessels, by labor-saving and novel machinery. Thus the price of asphalt pavement in New York, with the usual five years' guarantee, has been reduced from $3.05 a square yard, in 1894, to $2.23, in 1896. The following table shows the average prices of asphalt pavement for the years 1894, 1895, and 1896.

	1894.	1895.	1896.
For granite on sand	$2.87	$2.33	$2.15
For granite on concrete	3.50	3.15	2.75
Asphalt with 5 years' guarantee, on concrete	3.05	2.90	2.23
Asphalt with 15 years' guarantee on the old pavement	3.85	3.35	2.69

The reduction in the price of all other kinds of pavement has been equally great.

The different kinds of pavements require special cross-grades, or crowns. Heretofore pavements have been laid on very steep crowns, as this was considered necessary to their strength; also for the purpose of quicker surface drainage. The practice originated with the macadam pavement that generally prevailed in cities, and has been continued up to a very recent date. The confinement of the travel to the level portion in the center of the roadway caused this part of the pavement to wear faster than the sides, which were avoided on account of their steep side-grade; it is found that the pavement lasts longer,

and is more satisfactory generally, when paved on a slight crown. It is now the practice to make this crown as slight as possible, only sufficient for surface drainage. The flat uniform roadway, where wear is distributed over the full width, wears longer, and the horses are not so liable to slip (horses usually fall from slipping sideways); steep cross-grades, or crowns, are in no way necessary to the stability of the pavement. The crowns best suited for streets having grades up to 4 per cent. are found to be, for asphalt, wood, and brick, $\frac{1}{75}$ to $\frac{1}{100}$ of the width; for granite, $\frac{1}{117}$; for macadam, $\frac{1}{50}$.

The width of the wheel-tire has a marked effect on the durability of the pavement. Throughout Europe the width of the tire is regulated by law according to the weight of the load to be drawn. In this country the width of the tire is not compulsory. It is not at all proportioned to the load. If carters were compelled to restore the pavement injured by the too narrow tire, they would soon correct the abuse. An instance of this came to my notice on an application of the Metropolitan Traction Company for permission to cart an exceptionally heavy load, weighing seventy-two tons. The department required the company to make good any damage done to the pavement; consequently it built a special truck with tires ten inches in width.

In no instance is the benefit of a noiseless pavement more noticeable than about schools and hospitals, and on streets occupied exclusively by the poor. Physicians and health authorities bear witness to the benefits that have been derived from asphalt pavements, as not only noiseless, but preventing all liquid wastes from saturating the ground beneath them. It is this characteristic of the asphalt pavement that has improved the health of several large districts in this city occupied exclusively by tenement houses of the poorest kind. These streets were originally paved with the Belgian or cobble pavement, and had worn in ruts, in which the refuse water lodged. In this way the soil became saturated with filth, giving out poisonous air. Since these neighborhoods have been paved with asphalt, physicians and the health board have observed a marked absence of malarial diseases, and a lessening of the death rate. Good pavements not only promote the health of the community, but facilitate the renting of houses, and in no instance is this rental increase more noticeable than when a macadam pavement has been replaced by asphalt. In many instances rents on such streets have been increased by one-third, and it is safe to estimate that improved pavements have increased the rental of dwellings through the city at least ten per cent.,—far more on residential streets where asphalt pavement has replaced the cobble or Belgian pavement.

SIX EXAMPLES OF SUCCESSFUL SHOP MANAGEMENT.

By Henry Roland.

SURVEYING the field of human effort as it actually exists to-day in America, many large manufacturing establishments are found which have never had a strike, or any serious disagreement between the management and the workmen, and in which, although the wealth of the employer has vastly increased, the workmen are making small, but constant, gains in money and in comfortable living. Hence it appears that workmen can be happy and contented, and can in these particular cases lead lives which are not lacking in any essential of the very best living which workmen have the capacity to enjoy, without any change whatever from existing conditions of trade, commerce, or society.

If this result of financial success, coupled with full and happy lives of the workmen, can be reached in some instances without resort to coöperation or a paternal form of government or a general redistribution of wealth, it can be reached in many instances under existing conditions of trade and social economy, and so finally, by mere force of good example, it may become the rule instead of the exception that employers and workmen shall conduct their joint exertions for the enrichment and betterment of the world at large, in that peace and harmony and mutual happiness which must be held as the highest good of human existence.

It therefore seems highly important that the precise means by which this condition of harmonious effort is secured by these successful employers of wage-earners should be fully presented to the public, so that they may be clearly understood and thereby aid in the profitable management of industrial enterprises and the alleviation of those frightful miseries which seem the inevitable heritage of the workman in some places.

With this end in view, six successful establishments which have never had a strike or any serious difference of opinion between the management and the men have been selected for description. Each of these six concerns deals differently with its labor, all are highly-esteemed commercial successes, and all retain their workmen so long as their services are desired.

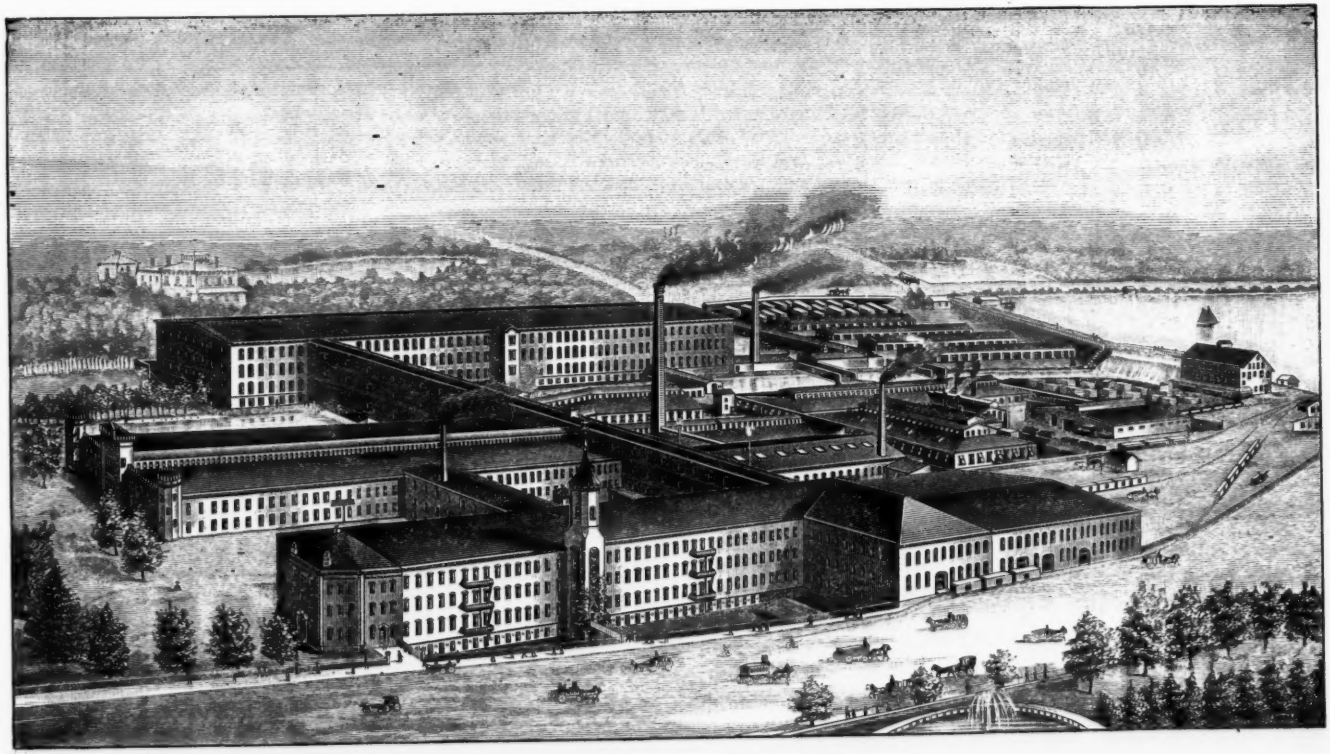
The first of these examples of fortunate wage-working has been selected because it has no settled or formulated policy, no defined

method of adjusting pay-rates, and hence no conspicuous or readily-defined guarantee of that immunity from labor troubles which nevertheless has been enjoyed for well towards a century of operation by the Whitin Shops located at Whitinsville, Mass., fourteen miles from Worcester, twenty-eight miles from Providence, and forty-four miles from Boston. The Whitin shops are reached from Whitin station on the Providence & Worcester line *via* a private electric road a mile and a quarter long, for freight, and a line of stages which meet the trains, for passengers.

Pictures of the Thomson-Houston electric locomotive, which can handle two loaded freight-cars, and of the track, are given.

The beginning of Whitinsville in the hands of the paleface dates back to 1660, when the general court of Massachusetts chose Mr. Peter Bracket and Ensign Moses Paine "for to purchase a title of the Indians containing about eight miles square, about fifteen miles from Medfield Town, at a place commonly called Masconsapong."

The tract was bought from Great John and three other Nipmuck chiefs for "the summe of twenty-four pounds sterling," and the deed signed April 22, 1661; and all interest in the tract of land covered by this deed was assigned to the selectmen of the town of Mendon, May 12, 1662. Civilization proceeded so gradually that in September, 1730, the town voted an appropriation of £4 for killing wild-cats, and the bounty on wolf scalps was not withdrawn until May 23, 1751. In 1772 a part of this tract became the "district" of Northbridge, containing 10,551 acres, and this "district" was raised to be the "Town" of Northbridge in 1786. The Blackstone river runs through Northbridge about one mile from its eastern border, and the Mumford river, on the banks of which the Whitin shops now stand, runs through the southwestern corner. Both these rapid streams gave good water-powers for nine months in the year naturally, and that of the Mumford river has been increased very materially by a system of artificial-storage reservoirs, as will be specified later. Between the two rivers rises Northbridge hill, a broad ridge with its highest point near the middle, falling somewhat towards the north; the Whitin (pronounced "White-in") Shops are at the south end of the hill, and mainly on the north side of the Mumford river. The Whitin water-power was first developed by the erection of Samuel Terry's saw mill in 1727 or 1728. There was iron ore at hand, as in 1700 the town of Mendon, which at that time included Northbridge and Whitinsville, voted that no person should carry any iron ore out of or from the town common under a penalty of 20 shillings for each load, 10 shillings to go to the informer and 10 to the town treasury, and an iron works was established at Mumford Falls in 1727 by Samuel Terry, clerk of



THE WHITIN SHOPS, LOOKING SOUTH FROM THE HILL.

Barrington, Mass. The next year Terry sold the saw-mill and iron-works to Hugh Hall of Boston for £212, gold; there was at that day a depreciated colonial currency, so that for a long time all statements of sale contained two numerical values, one currency and the other gold. Hall sold to Gershom Keys, trader, of Boston, in 1732, for £212, gold, and in 1733 Keys sold all the land and the saw-mill and half the iron-works to Jonathan Bacon, gent., of Bedford, for £368, gold. Keys soon bought back Bacon's interest in the iron-works, and sold his whole interest therein, this time half to Joseph Scott, brazier, of Boston, and half to Samuel Grant, "upholder" (promoter?), also of Boston, making the sales in 1735 and 1736 respectively, and receiving the total sum of only £123, gold, for the entire iron-works. Grant and Scott made additions, and at the time of the next sale, which was of Grant's half-interest, in 1736, to John Merritt, merchant, of Boston, for £168, gold, the works were described as having three fire-places, one hammer, and an "ore-yard." Merritt soon bought out Scott for £170, gold, and in 1739 leased the iron works to Thomas and Nicholas Baylis, iron-masters, of Uxbridge, for twenty-one years at £34 per year. The inventory of the works is given in the lease, and it is further described as "all furnished and suitable to make pig-metal into bar-iron." The place was for many years known as "Baylis' Refinery," and was held by Merritt after Baylis' lease expired, from 1760 to 1765, when it was leased to John Heseltine of Uxbridge. After Merritt's death the iron-works was sold by his executor to Col. Ezra Wood of Upton for £450. In 1794 Col. Wood sold two-thirds of the "forge and refinery" to his son-in-law, James Fletcher, and one-third to Paul Whitin, who had married Fletcher's daughter, Betsy, in 1793, and three great-grand-sons of Paul Whitin are to-day large owners in the Whitin Shops, one of them, G. Marston Whitin, being the treasurer and manager, and two others, C. W. Lasell and J. M. Lasell, being among eight stockholders who own the entire $600,000 capitalization of the present company; so that there has been a continuance of the name and business in the same spot for over a century.

The first Paul Whitin was a blacksmith, and soon began as a manufacturer by making hoes and scythes; and, during the suspension of English trade caused by the embargo of 1807-9, other farm-tools were added to the list of Whitin products, which then kept three trip-hammers and a power-driven grind-stone busy.

Paul Whitin, Sr., was a man of affairs, and presently established a cotton mill on the south bank of the Mumford river. This mill had 1,500 spindles, and here Paul Whitin placed one of his sons, John C., first at a very early age as a worker in all departments of cotton man-

ufacture, but very soon, while yet under twenty, as manager. Here this son, John C. Whitin, acquired that intimate knowledge of cotton-mill practice and the requisites of cotton-mill machinery which were, as events proved, to become the foundation of the Whitin Shops business of to day. In 1826 Col. Paul Whitin formed a partnership with his two elder sons, Paul, Jr., and John C., and in 1830 John C. began his long series of valuable improvements in cotton machinery by the invention of the picker. With two lathes,—undoubtedly hand lathes on wooden sheers, as they are said to have been both together worth less than $15,—and the labor of two assistants added to his own, John C. Whitin built his first cotton picker in about a year's time, finishing it in 1831, and securing a patent on it in 1832. Col. Paul Whitin died in 1831, in the sixty-fourth year of his age, and a new firm was formed, consisting of Mrs. Paul Whitin, Sr., Paul Whitin, John C. Whitin, and Charles P. Whitin, which almost immediately became the purchaser of the mill of "The Old Northbridge Manufacturing Company," and in the picker house of this mill, having a floor space 32×40 feet, the manufacture of John C. Whitin's new patent picker was begun. For it there was a steadily-increasing demand, so that for a long term of years most of the pickers used in this country were made at the Whitin Shops.

This success with his first venture in the line of improved cotton machinery led John C. Whitin to continue with a series of inventions in the same line, until now the Whitin Shops produce all of the machinery used in a cotton mill, except roving machinery, mules, and slashers, and the Whitin pay-roll has increased 800 fold,—from the two assistants who aided in the production of the first picker in 1831 to 1,620 names in 1896.

In 1847 the "New Shop," of which an illustration is given, was built, 306 feet long by 102 feet wide, two stories and basement, on the north bank of the river, at the water-edge. This was an enormous establishment for those days; it was equipped with the finest tools procurable, and the possession of this plant gave the Whitin establishment a prestige which it has never lost. In this same year, 1847, James F. Whitin, the youngest son of Col. Paul, was admitted to the firm. In 1860 John C. Whitin bought the Holyoke Machine Works on his own account, which he retained until 1864, when the firm of P. Whitin and Sons was dissolved, and the business of the concern divided, Mr. John C. Whitin taking the manufacture of machinery, and the cotton mills and various outside enterprises going to others. The Whitin shops were immediately increased by the erection of the "New Shop," 475 feet by 70 feet, three stories and basement, parallel to, and just north of, the 1847 structure. A large foundry

THE 1847 SHOPS, FROM THE NORTHEAST.

was soon added, and a large smithy, and in 1883 the new shop on the south bank of the river, 386 feet by 86 feet, was built, giving a total floor area of nearly eleven acres in 1889, which has been increased to about sixteen acres at this writing,—September, 1896,—while extensive additions are even now in progress. In 1870 the business was organized as a stock company, with a capital of $600,000, now owned by eight share-holders.

The history of the Whitin concern, as here sketched, gives strong indications of the Whitin characteristics of fair-dealing and consideration of the rights of others, which alone could make the long-continued and amicable association of Col. Paul Whitin and his sons,

THE WHITIN IRON WORKS.

and their sons, and their sons' sons, possible, so that now the fourth generation of the family is in control of the great business which has grown up from the small beginnings in the little iron-works at the falls of Mumford river at the place commonly called Masconsapong. Except in its fierce and uncompromising disapproval of Medford rum and all allied beverages which makes it impossible to alleviate a nineteenth-century normal thirst in Whitinsville of to-day by open purchase, the Whitin character is marked by a spirit of broad toleration in all directions,—a full and generous interpretation of the rights of others, no matter how dependent their position, or how feeble their powers for the maintenance of those rights.

TERRACING ON THE HILL OPPOSITE THE SHOPS.

The Whitin Shops are now under the immediate management of Mr. G. Marston Whitin, treasurer of the company, and Mr. Taft, "agent" by title in the works, who fills the office of managing superintendent, as did his father before him, so that for more than thirty years the Tafts, father and son, have had control of the workmen of the Whitin Shops. The one other marked trait of Whitin character is a love of beautiful surroundings, which found expression in the castellated architecture of the 1847 shops, the half-octagon eastern end of the "New Shop" of 1864, fine terracing and landscape effects produced on the south end of the hill, just across the road north of the shops and in full view of the shop windows on that side, and in the

streets and public buildings of the town. The natural beauties of Whitinsville were very great, and they have been preserved and added to by irregular streets, ornamental stone retaining walls and bridges, and the preservation of trees, which our simian ancestry makes us ever regard as symbols of home and rest, so that Whitinsville is everywhere pleasing to the eye of the beholder.

After inspection of the works under the guidance of Mr. Taft, a conversation with that gentleman and Mr. G. Marston Whitin brought out the surprising fact that the management of the labor was without even the faintest trace of a defined policy, except that of a full con-

A STREET IN THE WHITIN TENEMENT DISTRICT.

sideration of the effect of any business move on the earnings and peace of mind of the workmen. "We often do not do what we would prefer to do so far as we are concerned, because it would affect our men unfavorably," said Mr. Whitin; "we do not consult our men at all; we know, of course, how they are situated, and what effect any change will have on them, and we let their side of the matter influence us when we can consistently do so."

There is no fixed policy as to piece-work or day-work. A large part of the work is always at piece-rates, but under varying conditions the piece-rate on a certain job may be discontinued and day prices be substituted. The spindle-forgers, for instance, are now on day-pay,

A SCHOOL BUILDING, FROM THE ORNAMENTAL GROUNDS.

though, if the demand for extreme production was urgent, these hammer-men would be put on piece-rates, which would increase their day-pay and the output together. "When I want more work," said Mr. Taft, "I put the spindle forgers on piece prices; then they fix their fires in their own time, and run their pay up, and get out more work for me; when we are not driven, we put the spindle jobs back on day-pay, and get less work, and may be pay a little less per spindle. I don't know exactly. If the shop is running easy, we go easy on the men; if the shop is crowded, we crowd the men a little, and pay them

MEMORIAL BUILDING, PRESENTED BY THE WHITINS TO THE TOWN.

more money." Mr. Taft smiled when he confessed to this elastic policy, and so did Mr. Whitin.

The Whitin concern owns a very large amount of land, and has about six hundred tenements, usually in the form of double dwellings, rented to employees; the rental varies from $3.50 per month for a five-room tenement to $14 per month for an eight- or ten-room detached cottage. This tenement district extends along the bank of the pond, and rises on the foot of the hill. The location is beautiful, and in many cases the occupants maintain flower-beds; in most cases, however, exterior adornment is neglected. The pond and surrounding hills give a beautiful outlook. The air is pure and cool; the water-supply is a gravity system from two large springs of great purity, and belongs to the company. It is the rule for the workmen to marry, and children are abundant, healthy, and happy.

The nearest approach to a strike in the Whitin Shops occurred when the ten-hour law was passed in Massachusetts. The workmen asked for the ten-hour day from the member of the Whitin family at that time in charge, and it was given them, with the information that the works would be fenced in, and provided with locked gates. The

A WHITINSVILLE DOUBLE TENEMENT.

THE TENEMENTS ON TUESDAY MORNING.

THE TENEMENTS FROM ACROSS THE POND.

working-hours had been nominally eleven; if a workman was five or ten minutes late, it was not noticed, and, if a hand wanted a piece of pie in the forenoon, he simply walked out of the shop to his home after it. The mail came to the little post-office across the road from the works at five in the afternoon, and, of course, nothing was more reasonable than that a workman should go over to the office to see if he had any important letters. There are to-day fish in the pond, and fur and feather on the hills about Whitinsville, and in the old days

THE ELM-SHADED POST-OFFICE.

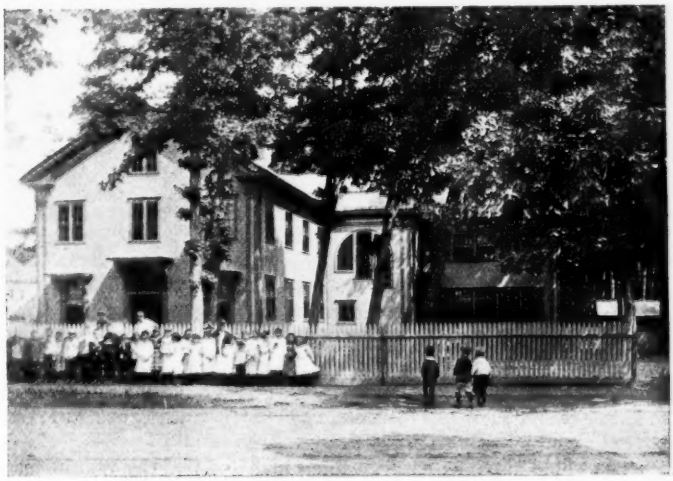
many of the hands took their guns to the shop with them, and a flock of ducks in the pond, or even a musk rat swimming across, was the signal for a sporting expedition. The ten-hour day with the fence and the locked gates made such a change in affairs that some of the old hands were heart-broken and resigned their places, and the management obtained much better results from a day's labor than ever before.

This ten-hour day incident was the only one in the whole time of four generations of Whitin management that caused any hands to leave the shop, and in this case there was not the remotest approach to a strike. The old hands who quit simply could not brook the idea of a locked gate. There has never been any formal recognition of the "rights" of the workmen, and, in point of fact, the Whitin management is simply a despotism, with power to banish any objectionable personage. Whitinsville has five or six thousand inhabitants,—perhaps more. Statistics were unobtainable. The industries are the Whitin Machine Works, Whitinsville Cotton Mill, controlled by Edward and Arthur F. Whitin, Whitinsville Spinning Ring Co., Paul Whitin Mfg. Co., and Linwood Cotton Mill. All of these concerns are controlled by the Whitin family and its branches, and no workman not approved by the Whitin interest could remain in the place. There is no drink sold openly, or to the knowledge of the Whitins. Schools are excellent, $80,000 having been expended on school buildings recently; there is a free night-school for adults, which has from 80 to

100 pupils during the winter months. There are numerous Protestant churches, and a large Roman Catholic church.

The Whitin "Memorial Building," a gift from representatives of the family to the town, contains fine assembly rooms, a well-selected circulating library, a music room, and the needful rooms for the transaction of town business. The Whitinsville Savings Bank has a total of $633,000 deposits, mainly to the credit of the workmen employed in the various manufactories conducted by the Whitin family and its branches. The exact amount of deposits to the credit of the iron-works hands could not be obtained, but it is a large sum. From 1835 to about 1865 the iron works borrowed the savings of its workmen at 6 per cent. compound interest, renewing its notes in April of each year with interest added. This arrangement was closed before the establishment of the savings bank, which pays 4 per cent. on deposits.

There is no theatre in the place. Nor is there an objectionable resort. A few only of the machine works employees own their houses,—perhaps one hundred and fifty all told. Churches, secret societies, Masons, Odd Fellows, Knights of Pythias, the Order of Red Men, the Musical Society of Whitinsville, and cycle clubs furnish the social distractions. The labor at the machine works includes a considerable number of Armenians and some Turks; the Armenians recently demanded the discharge of the Turks, and, when this was refused, about forty of the Armenians left. This was purely a race matter.



SCHOOL FOR THE WHITIN IRON-WORKS CHILDREN.

The harmony existing between master and man at the Whitin machine works is due to the beautiful and healthful and comfort-giving environment, to the heredity of obedience and confidence transmitted from generation to generation of workers under one management, and the Whitin sense of justice and the employer's duty to protect the defenceless. The workmen are happily situated, their children are robust, and their wives are contented. Wages are low, but rents are low, and there is no car-fare to pay, or drinking-place to rob the workman's family of his earnings; and the work is such that a man must be wholly decrepit before he cannot produce a fair daily output.

WHITIN MANSION, ON THE HILL OPPOSITE THE WORKS.

There are over a hundred workmen who have been more than twenty-five years in the shop. The oldest living hand is Sylvester Keith, who began in 1839, at 8s. 6d. per day, or about $1.42. At that time Keith paid $18 a year house rent, and most provisions were cheaper than now; the present average pay for machinists is from $1.65 to $1.70. The high pay-roll was given as $16,000 or $17,000 per week, which would make the grand average for 1,600 hands about $10. Sixty cents a day was given as the low apprentice pay. It is quite the rule for sons to follow the fathers into the shop, and some names appear on the pay-rolls continuously from the first until now.

The whole case may be summed up in saying that the Whitin machine works hands are happily situated, comfortably housed, lightly

AMONG THE WHITIN TENEMENTS.

A GROUP OF WORKMEN'S FAMILIES.

THE WHITIN THOMSON-HOUSTON ELECTRIC LOCOMOTIVE.

THE ELECTRIC ROAD FROM WHITIN TO WHITINSVILLE.

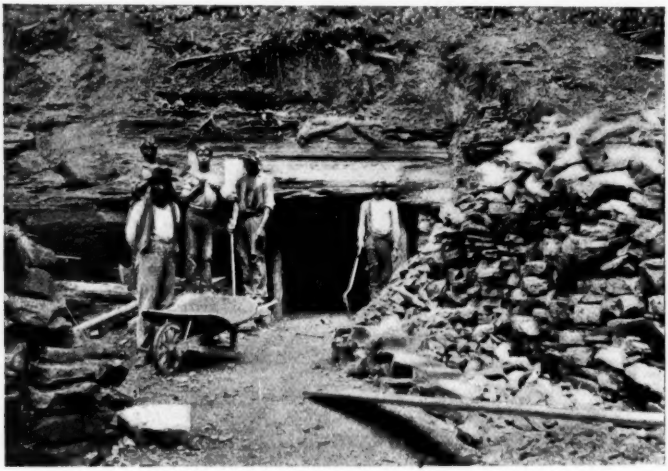
worked, surrounded by beautiful sights, fully occupied with easy labors by day and innocent amusements during their leisure hours. They marry and have children, and their lives are full of the principal possibilities of human enjoyment, and back of all stands the Whitin management as a special providence, considering, first of all, the limitations and the needs of their workmen, in a highly uncommercial manner, which, nevertheless, has led to a sound and persistent commercial success.

The original fifty or sixty horse power of the falls of the Mumford river has been increased by an extended reservoir system to 400 h. p. This is supplemented by 700 h. p. of steam. The floor-acreage is almost continually being extended, and the reputation of the Whitin cotton machinery is of the highest; all of the work produced is as good as the shop knows how to make; improvements in design are constantly produced, and there is a disposition to increase the weight, and to substitute iron for wood in framing, and to replace the light old tools with heavier modern patterns. The shop is a credit to the country, because of its mechanical ability and commercial integrity, and to humanity, because of its unremitting application of the wisdom of its managers to the betterment of the living conditions of its workmen.

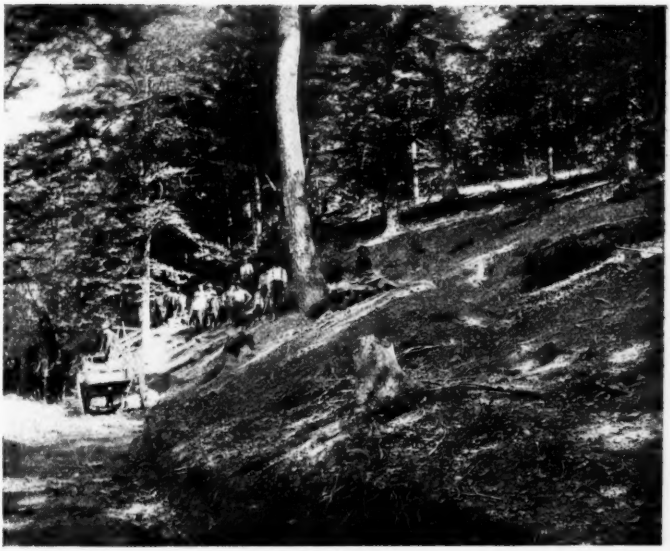
THE PHOSPHATE-ROCK DEPOSITS OF TENNESSEE.

By Lucius P. Brown.

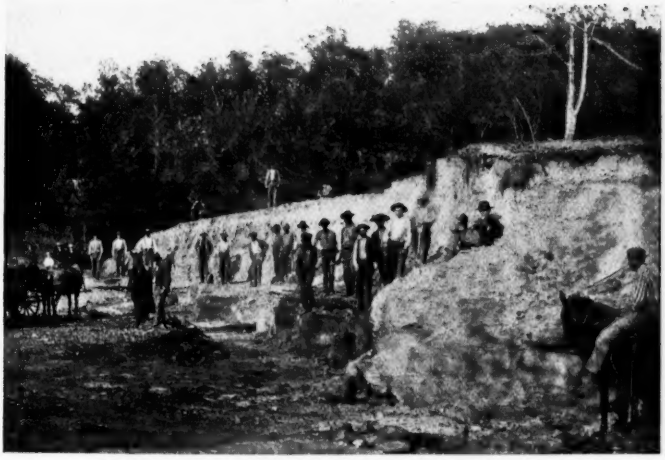
THE very considerable development in phosphate mining in the United States within the past six or seven years, and the attendant enlargement of the manufacture of fertilizers, have probably made any extended reference to their uses and value unnecessary here. Suffice it, then, briefly to mention that the phosphoric-acid-yielding materials (exclusive of bones) that have been, or are now being, worked are of two classes,—*viz.*, mineral phosphates (apatites and phosphorites) having a definite chemical composition and exhibiting the other properties inherent in a true mineral, and phosphate rocks having no fixed and definite chemical composition and lacking the homogeneous nature and definite physical properties of minerals. The former occupy now a comparatively insignificant position, although well adapted to manufacturing, as the cost of mining does not permit them, except for a few special purposes, to enter into competition with rock phosphates in the markets of the world. The supply of the latter is derived from four main fields,—*viz.*, the deposits of Algeria and Tunis, in northern Africa, and the deposits of South Carolina, Florida, and Tennessee. Of these the African deposits are, so



AN ENTRY WAY, TENNESSEE PHOSPHATE MINES.



OPENING A NEW MINE.



THE SIMMONS MINE. STRIPPING JUST REACHING THE VEIN.

A GENERAL VIEW. DUCK RIVER PHOSPHATE COMPANY.

far as mined, of medium or low grade, but are important on account of their proximity to the European markets. The South Carolina rock is of about the same grade, but, on account of the opening of the higher-grade deposits of Florida and Tennessee, this field is no longer so important as formerly. For a long while it was almost the only source of phosphoric acid.

THE OLD PHOSPHATE-ROCK HOUSE.

From whatever field derived, the phosphate rock must, for use, be first ground to an almost impalpable powder, and then mixed with about an equal weight of sulphuric acid. The result of this union is known as "acid phosphate," and contains practically all the phosphoric acid in such a condition as to be soluble in the soilwater (it was before insoluble) and therefore available to the plant. This material forms the basis of all manufactured fertilizers, and is either used alone, or is mixed with materials yielding ammonia and potash, to form complete fertilizers. Finally it may be noted that phosphate rock is usually sold by its content of "bone phosphate," or tribasic phosphate of lime, $Ca_3 (P O_4)_2$, and, in addition to a certain percentage of this constituent, it must contain not over a certain maximum amount (in the United States usually three per cent.) of the combined oxids of iron and alumina, with a minimum of moisture. The value of the rock, therefore, is, in the trade, always spoken of in terms of bone phosphate, either with or without mentioning percentage of iron and alumina.

Besides those deposits of phosphate-rock in Tennessee which are now being mined, there are some that do not seem to be commercially available, but the title of this article demands that we should give them at least a passing notice. One of these deposits belongs geologically in the Trenton limestones, and is sometimes found lying immediately below the Devonian beds, at other places being separated from them by several feet of Niagara limestones. It is of too low a grade (about forty per cent. bone phosphate) to be of industrial importance, but it, or a cognate formation, has undoubtedly very much to do with the surpassing fertility of the "blue grass country" of Kentucky and Tennessee. The other two deposits lie near the Tennessee river in Perry county, and are of the lower carboniferous age. They have been very well described by Mr. C. Willard Hayes.* One of these consists of a breccia of chert fragments, the matrix of which is phosphatic; the other is a true bedded deposit. Neither of them contains more than forty per cent. of bone phosphate on an average.

The phosphate-rock deposits now worked all lie in Hickman and Lewis counties. These counties lie on what is known as the western "Highland Rim," an elevated region surrounding the great interior basin of Tennessee. The rocks of the basin itself consist of Upper and Lower Silurian limestones; those of the Highland Rim consist of Lower Carboniferous cherts and shales, as the upper rocks of the hills, while lying beneath them are the Devonian and Silurian formations. The region is one of wooded hills, and clear and rapid streams run-

*See Annual Report of United States Geological Survey, "Mineral Resources of United States Non-Metallic Products."

ning through fertile valleys. The hills range from 800 to 1,100 feet in height, and, while the landscapes lack the grandeur of a mountain region, they have, especially in summer, a quiet and peaceful beauty of their own. To the west the Highland Rim slopes with the dip of the strata to the low plateaus and river-bottoms of west Tennessee, which finally end at the Mississippi.

The phosphate deposits belong among the Devonian formations, and are of two kinds,—the nodular and the bedded. They are accompanied by the Chattanooga black shale, which is one of the most widely spread of the geologic formations of the southern states, though usually not of great thickness. Lying beneath this, and often interbedded with it, we find the phosphate stratum, or its representative, while, embedded in a peculiar stratum at the top of the shale, or, sometimes, in the shale itself, we find the nodular phosphates, or "Kidneys." These have been very well described by Dr. Safford, the State geologist of Tennessee. They are "round, oval, kidney-shaped bodies, and are usually more or less flattened." They present a smooth surface, are usually very distinctly of a concretionary structure, contain a considerable proportion of organic matter, which gives them a black or dark gray color, and are an excellent material for the manufacture of acid phosphate, but have nowhere been found in sufficient quantity to justify mining alone, and so are made use of only as they are procured in the mining of the bedded deposit. The latter, so universally known as Tennessee phosphate, is unique in being not a deposit of nodules or pebbles scattered through a clayey or sandy matrix, but a true stratum, in some places as much as fifteen feet thick. It is also the oldest phosphate-rock deposit, in point of geologic age, now worked.

I cannot better describe it than by quoting Dr. Safford's description, written about 1869, as follows: "In addition to the kidneys at the top, the Chattanooga shale has, immediately below it, very generally a dark gray bituminous fetid sandstone, usually fine grained and from a few inches to fifteen feet in thickness. In Wayne, Hardin, and in the southern part of Lewis county this sandstone is often thick enough to be quite conspicuous, forming ledges along the slopes of the hills and sometimes small local plateaus. North and east of Wayne and Lewis the sandstone below the shale is not so thick; in fact, it very often measures but the fraction of a foot."

It will be noted that Dr. Safford refers to this as a sandstone, and such in fact it becomes in the localities mentioned by him, the transition of sandstone into phosphate being so gradual as to escape detection except to one thoroughly acquainted with the latter,—which, indeed, may itself easily be mistaken for a sandstone.

Prof. N. S. Shaler has well said that "there is no substance of equally wide diffusion, among those of considerable commercial importance, which, in the present state of popular knowledge, so readily escapes detection as lime phosphate." This explains how it has happened that all the important phosphate discoveries in the United States have been the result of accident; and this was particularly the case in Tennessee, since the phosphate region has been the scene of much activity by prospectors for iron, oil, etc., and the old "Aetna" furnace in that section is noted in the annals of iron-making in the State. The phosphate rock itself has been often used by builders of chimneys, etc., and in one case a house was built of it by an eccentric farmer. This structure consists of a single room about twenty by thirty feet. It was built by its former owner without help and is said to contain no particle of iron in any shape in its make-up. In view of its singular history and of recent developments, it is a most interesting relic.

While the phosphatic character of the "kidney deposits" has, thanks to Dr. Safford, been known for some years, the true nature of the bedded deposit was not discovered until 1893. In that year two gentlemen living in Linden, Tenn., had conceived the idea that coal ought to be found in this section, and, in the course of their quest, there was sent to them by a Mr. Harder, living near Palestine, Lewis county, some peculiar-looking rocks which he had found while fishing in Swan creek. These samples were sent for analysis to Mr. J. C. Wharton of Nashville, who found the greater portion of them to be black shale, but discovered among the lot a piece of high-grade phosphate rock. Upon receiving his report, the two prospectors went to work to secure options, and others went into the same business. By July, 1894, at which time the first regular shipments went out, three companies had been organized, and now eight or nine are at work.

As mentioned above, the phosphate stratum is nearly or quite as persistent as its companion, the black shale, but those deposits that are rich and thick enough to work have so far been found of limited extent. Only two well-defined fields are now known,—*viz.*, that of Swan creek and Totty's Bend, which form one field, and a smaller one on Leatherwood creek in Hickman county. The extent of the latter is small, and not yet accurately determined; the former is about 20 by 4 or 5 miles in dimensions. Workable rock does not exist wherever rock is found over this area, but occurs usually in beds of 40 or 50 to a 100 or more acres in extent. Estimates of the total quantity "in sight" would at present be little more than guesses, but, as a seam of 20 inches' thickness (which is about the average now worked) contains about 5,400 tons to the acre, a simple calculation will show that there is no immediate danger of an exhaustion of the supply.

The bedded rock may be conveniently divided, in a general way, into two main varieties,—*viz.*, compact or fine-grained, and oolitic. These again may be divided into blue, or blue-black, and gray. These divisions shade into each other, and can not be regarded as absolute, but are in use by the miners as a convenient classification. The blue much exceeds the gray in quantity, and therefore has been regarded as the typical color of Tennessee rock. Oolitic blue rock shows to the eye a coarse granular structure, which, under a hand-glass, is seen to be due to numerous small rounded or flattened grains with glazed surface, and to the shell casts of minute shell-fish of which the most numerous had a spiral shell (Cyclora). This oolitic rock shades by degrees into the compact variety. The latter is usually higher in bone phosphate than the oolitic rock; in other words, the fineness of grain of the rock is in some degree an index to its grade. The blue rock sometimes contains as much as 80 per cent. of bone phosphate with from 1 to 3½ per cent. of iron and alumina.

Its color is apparently due to a considerable proportion of organic matter, and it contains, as mentioned below, some pyrite. Along the outcrop and along the joint-planes in the bed the presence of air and the access of superficial waters has oxidized this pyrite and organic matter, and changed the color of the rock to tints ranging, according to the amount of pyrite originally present, from gray to deep red brown. Blocks are often quarried showing on all the edges this change, but preserving a blue center, which gives a very handsome effect. Rich oolitic gray rock is at present known in only a very limited area. Its oolitic structure is more marked than that of any other rock, in the field, and it contains more shell casts. Analysis shows usually from seventy to seventy five per cent. of bone phosphate with low iron and alumina. At one of the mines this gray rock forms the upper portion of the stratum, the lower consisting of a blue oolitic deposit running about five per cent. lower. This is the only place in the field where this formation occurs, though it is not usual to find a seam the same from top to bottom, there being ordinarily two or three distinct layers, one or more of which, however, are usually thin and therefore unimportant.

The chemical constituents of the Tennessee phosphate rock are practically the same as those of all the other deposits of the world, except that it contains a considerable percentage of pyrite (bi-sulphid of iron). A good deal of discussion has taken place as to the action of this material in the acid phosphate shed, and its effect upon the acid phosphate, but it seems now very well established that, if it has any effect at all, it is not an injurious one. Alumina is present in only small amount, and fluorin is a constant ingredient. A table of analy-

ses, made mostly for commercial purposes, and therefore incomplete, but showing well the general characters of the rock, follows:

ANALYSES OF REPRESENTATIVE MEDIUM AND HIGH-GRADE ROCKS.

CONSTITUENTS.	Oolitic Gray Rock (a)	Compact Gray Rock	Compact Blue Rock.	Compact Blue Rock from another mine.	"Kidneys."
Phosphoric Acid	33.73	36.21	33.29	(a) 32.67	30.64
"Bone Phosphate" on dry basis	73.63	79.77	74.03	(a) 72.23	67.14
Iron Oxid	2.06	2.84	2.35	(a) 2.14	3.42
Alumina		.41	.90		
Iron Sulphid (Pyrite)	2.09	None	3.15	(a) 4.52	.43
Carbonic Acid	3.54	.....	1.12	1.84	.98
Equivalent to Lime Carbonate	8.01	.....	2.55	4.20	.48
Moisture	.25	1.04	1.96	1.40	.....
Organic Matter	1.13	.....	2.44	....	.....
Lime (CaO)	47.18	.....	46.67	47.37	.....
Magnesia	.23	.....	.44	....	.....
Sand and Insoluble Matter	2.88	....	4.21	2.22	.....
Calcium Sulphate	.....	.....	4.88	5.65	.....

a. Average of fifteen samples from same mine.

Tennessee rock has shown itself to be probably the best material yet discovered for the manufacture of acid phosphate. It grinds almost, or quite, as easily as the Florida pebble or South Carolina rock, and dries out quickly after mixing to an easily friable product, which contains a low percentage of insoluble phosphoric acid, and a correspondingly high percentage that is available. It appears to be so firmly fixed in the manufacturer's favor that, other things being equal, he will always give it the preference over other sorts on the market.

In marked distinction to the necessity that prevails in Florida and South Carolina, no expensive plant is required in Tennessee for mining and preparing the rock for market. The problems that confront the miner are essentially the same as those met in working a thin and horizontal seam of coal, allowing for the difference of the material; or perhaps they more closely resemble those encountered in the mining of a thin seam of Clinton red hematite. Up to the present time, a very large portion of the rock shipped has been won by stripping, but this must necessarily grow less important. Most of the veins mined have a good roof of black slate, but again the miner finds the slate badly decomposed, and he must use a large amount of timber. This will doubtless prove to be one of the chief difficulties that will be met, another being, as mentioned, the thinness of the seam. While

the character of the deposit changes, both in thickness and quality, in going any distance (say half a mile or more), the quality in any one mine changes only gradually, though very perceptibly. Hence a careful oversight of the rock mined, and frequent analysis, are advisable, since it may very well happen that the quality of the rock may seriously alter without the change being visible to the naked eye. The thickness of the seam in any mine, while it changes slightly, pinching and expanding again (which is probably usually due to the inequalities of the limestone floor beneath it), is also fairly constant. Mine-drainage gives no trouble, as the seam is approximately horizontal, but the ventilation must be looked after to about the same extent as with a red-ore seam. Tennessee rock, in consequence of its peculiar occurrence, is so free from sandy or clayey impurities that it requires no washing, and no drying except when wet by rain or snow. The usual practice is to break it in a crusher to about a two-inch size, but a great deal of rock is shipped in the lumps in which it comes from the mine. A practice of handling that is to be highly commended is to pass the broken rock through a rotary screen, thus cleaning from adherent clay or sand. Tipple screens, such as are used at coal mines, have much the same effect. The screenings, consisting of the smaller particles of the phosphate, and of the clay and sand, and usually containing not less than sixty per cent. bone phosphate, may then be sold either to the manufacturer or for direct application to the soil. The rock which passes by the screen is thus freed of a considerable proportion of its iron and alumina, and the percentage of bone phosphate is also raised slightly.

The natural difficulties with which the Tennessee miner has had to contend have been insignificant compared with those due to artificial causes, chief of which have been the "hard times" prevailing for the last three years, preventing the obtaining of funds with which to build railroads to the mines, which all lie from two to eight miles from the Centerville Branch of the Nashville, Chattanooga & St. Louis Railway. Only one mine has a road to it; this is a narrow-gage, four miles long. Much the larger part of the rock already shipped out has been hauled in wagons from the mines. The Nashville, Chattanooga & St. Louis railway have now put in a road to the mouth of Swan creek, and the probability is that we shall, before the end of the year, see connection of the mines, not only with this railroad, but with the Louisville & Nashville as well.

The future of this phosphate field seems well assured. The production of phosphate rock in the United States during 1895 was 1,007,773 tons. Of this at least 600,000 tons was used in this country. Now Tennessee practically controls those markets not directly

within reach of ocean-going vessels, and has, moreover, markets in the north and northwest that are expanding daily, as the virgin lands in those sections wear out, and the farmers learn the advantages of fertilizers intelligently applied. This being the case, it seems to me well within the bounds of reason to say that Tennessee should, in three or four years, furnish at least two hundred thousand tons of rock per annum, if the proper transportation is furnished. As soon as the short branch railroads now in prospect are built, a very considerable expansion of mining may be looked for, and this industry should take rank among the foremost in the southern States. Fair railroad rates, however, are a prime necessity for this result, and it is to be hoped that the liberal policy already inaugurated by the roads tapping the field will be continued. With an improvement in European prices, it is possible that some effort might be made to establish a demand for the rock abroad, but the domestic market is now, and must always be, that upon which the miners here should mainly depend, and which they should seek to completely supply. The demand from this source promises to take all of their output for some time to come, and it is therefore unlikely that we shall soon endeavor to compete with our Florida brethren in the decidedly unsatisfactory and uncertain European market.

Since the preceding article was written, a discovery of phosphate rock has been made, at the village of Mt. Pleasant, which will undoubtedly change greatly the general aspect of the phosphate business in Tennessee. Mt. Pleasant is situated in the western part of Maury county, some fifty miles south of Nashville, and about twenty miles east of the Swan creek valley. The region surrounding it resembles very closely the well-known "Blue Grass Country" of central Kentucky, except that it is more rolling in contour and more picturesque in its outlines. Agriculturally, it is one of the richest sections of the United States, and has given birth to more than one man noted in the history of the State and nation. It lies on the western edge of the "Interior Basin" of Tennessee, a magnificent expanse of gently-rolling plains and low limestone hills which extends from the foothills of the Cumberland mountains almost to the Tennessee river on the west, and much less broken and rugged than the "Highland Rim" region already mentioned. Traversing the basin at intervals, and imparting to its scenery a picturesque quality which makes it one of the fairest lands that the eye of man ever rested on, are ranges of high, but rounded, hills, either wooded, or, when cleared, clothed to their summits in a growth of short, sweet, nutritious grasses. The rocks of these hills are the Lower Carboniferous and Devonian shales and

impure limestones, but the rocks of the basin proper are limestones, almost entirely of Lower Silurian age. The newly-discovered phosphate rock seems to be the result of the concentration of a highly phosphatic limestone, known by Dr. Safford's name of the "Capitol Limestone" (so called because of the fact that the State capitol is built of it), belonging to the Nashville (Cincinnati) group of the Lower Silurian. The concentration of this limestone, containing about fifty per cent. of bone-phosphate, to a phosphate rock containing seventy to eighty per cent. has been effected by leaching by carbonated waters, and probably also by a certain amount of segregation. This process seems to be going on even now, and can be easily observed. The dark blue limestone, much resembling the blue oolitic rock of the Swan creek district, changes first to a light gray, somewhat porous rock, seen as a coating on the limestone, and to a reddish or brownish gray, very porous, and rather soft material, when the change is complete. The beds of phosphate seem to be somewhat irregular in extent, but apparently are usually of fair size. Often they are much cut up by chimneys of unaltered limestone extending up through them. The overburden on the beds seems to be light,—usually only a few feet,—and they themselves range in thickness up to eight or nine feet. The rock does not lie in the beds, as in the Swan creek district, in one or more heavily-bedded layers, but in plates hardly ever more than twelve inches in thickness, or two or three feet in breadth, into which the miner easily makes his way with pick and shovel, without the use of drill or powder. This, of course, cheapens the mining of the rock very greatly. Washing, which *may* be necessary, and drying, which is certainly so, may, however, reduce the advantage which this circumstance gives to this field over the Swan creek district. The chief point in which the field excels the older one is the matter of transportation, as it lies directly upon the Nashville, Florence & Sheffield Railroad, a branch of the Louisville & Nashville system. The rock therefore can be loaded on the cars at the mines, thus eliminating the wagon-haul,—that giant in the path of the Swan creek operators.

Analysis of the Mt. Pleasant rock seems to show that, in the natural condition, and without washing, it runs slightly higher, both in bone phosphate and iron and alumina, than the Devonian rock. An average of forty-nine samples running over 65 per cent. showed 74.14 per cent. of bone phosphate, with a maximum of 81.06 per cent. of bone phosphate, and a minimum of 1.86 per cent. of oxid of iron and alumina. It is as yet too early to say what percentage of iron and alumina can be guaranteed in extended mining operations, but the indications are that these ingredients will not give serious

AN OPEN-CUT MINE, SOUTHWESTERN PHOSPHATE COMPANY.

ROCK PILED BEFORE SHIPPING, SOUTHWESTERN COMPANY'S MINE.

VEIN AND MINED ROCK, TENNESSEE PHOSPHATE COMPANY.

BEGINNING OF AN ENTRY. DUCK RIVER PHOSPHATE COMPANY.

LOADING-PLATFORM AND OFFICE, SWAN CREEK PHOSPHATE COMPANY.

trouble. The rock contains no pyrite, and from two to six or seven per cent. of carbonate of lime. Trial-mixings by manufacturers have given excellent results, the product being of a gray color, quickly drying and with a good percentage of "available" phosphoric acid.

While the effect of this discovery on the phosphate industry in Tennessee will be—nay, has already been—very great, it is at present impossible to say in what way this will further manifest itself. Experience in other fields would point to the establishment of factories at points adjacent to the fields where favorable transportation facilities are presented.

A MILL AND CRUSHER. WAGONS WAITING TO LOAD.

FIRST WORKINGS OPENED IN THE MOUNT PLEASANT REGION.

The extent of the Mt. Pleasant field is as yet not accurately known. The Capitol limestone is a widely-disseminated formation in the State, and phosphate rock has already been found at many points outside the Mt. Pleasant district, but so far either too poor in quality, or in too small quantity to admit of mining. It is, however, of course, very possible—indeed, may be said to be probable—that good deposits yet remain for discovery in other sections of the Middle Basin. It is also not at all improbable that like beds will be found in other areas where the Cincinnati limestones exist. It is of interest to note the fact that, except for some rather unimportant deposits mined some years since in Wales, these are the first beds of commercial importance to be found in the Lower Silurian rocks, despite the fact that as long ago as 1888* Prof. N. S. Shaler had pointed out the promising character of this horizon as a field for search for phosphate deposits, and had strongly recommended that it be thoroughly explored.

*Bulletin 46, United States Geological Survey, "The Nature and Origin of Deposits of Phosphate of Lime."

THE WATER-SUPPLY OF A TROPICAL CITY.

By Raimundo Cabrera.

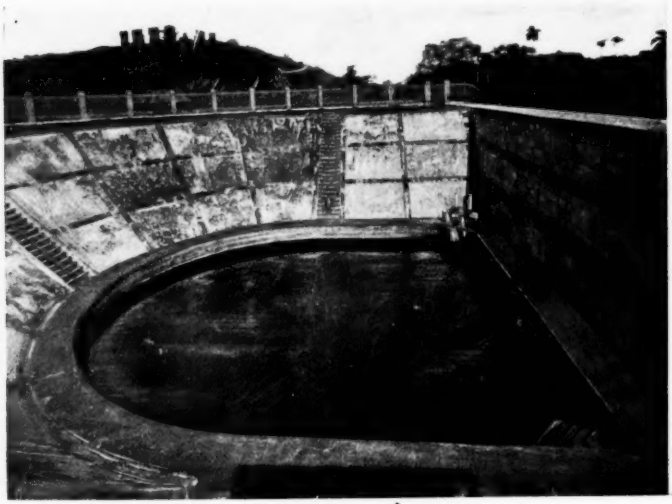
THE island of Cuba, apart from the great sugar plants and a few buildings of classic architecture found in the cities, does not afford many works in which the engineer could find models worthy of admiration and study. But there is one work which claims the attention of natives as well as foreigners, because of its magnitude, tusefulness, solidity, and the wonderful skill exhibited in its construction. Such is the Havana aqueduct, known as the "Canal de Vento."

The great number of foreigners who visit Cuba in the winter season, and especially American tourists, never fail to make an excursion to the place where these waters are gathered, and all return impressed by the magnitude of this wonderful piece of hydraulic construction.

In the first century of its foundation, the city of Havana obtained its water-supply from a brook called Luyanó, which empties into its magnificent harbor. The water was brought down by boats, which ascended the stream for a considerable distance in order to secure the water in its purest possible condition; but, with increase of popula-

VIEW ON THE ALMENDAREZ RIVER.

RESERVOIR OF THE OLD HAVANA AQUEDUCT.



DAM AND RESERVOIR AT SPRING.

STATUE OF FRANCISCO DE ALBEAR, IN HAVANA.

tion, it became apparent that this system, together with the wells and cisterns then in existence, was not sufficient, and recourse was had to the most common means employed in the old civilization, which consists in bringing the water to the city by means of a channel or artificial conduit from the Almendares river, a distance of more than nine miles. That work was done in 1591, and for two and a half centuries it furnished the only supply of water the population could obtain.

The works consisted of a simple upright dam for the purpose of elevating the surface of the water in the river, and also of a gate at

GREAT GATE TO WITHHOLD OR PERMIT THE WATER OF THE SPRING TO FLOW INTO THE CANAL.

GREAT GATE-HOUSE AT THE MOUTH OF THE TUNNEL BELOW THE RIVER AND THE MOUNTAIN.

the head of the discharged conduit, which is called "El Husillo" or conducting channel. From there the water ran nearly on a level for about 5,000 meters from the dam, at a speed of 0.20 meter per second, furnishing a maximum supply, at the entrance of the channel, of 0.80 cubic meter per second, or 70,000 cubic meters daily, of which, on account of the several drains made for irrigating purposes, not more than 17,500 cubic meters reached the city.

The channel was nothing but a very imperfect conduit of drinking water, generally filthy, and unhealthy on account of the frequent overflows of the swampy brooks encountered in its course; and yet the cost of this primitive aqueduct was $210,961, and the annual expense of keeping it in repair was, on an average, $35,000.

In 1831 was begun the construction of a new aqueduct, intended to take the place of the old and imperfect one, and in 1835 it was completed; it was designed to take the same storage waters from the dams of the Husillo, and conduct them through a reservoir and filtering apparatus, and thence to the city through iron mains. This aqueduct still exists; its cost was $781,679.

The water is drawn from above the dam of the Almendares river through an open conduit of ashlar masonry, with a good gate through which the water passes to the settling basins. These are also uncovered, but not so the filtering tanks which immediately follow them, and into which the water enters, passing to each of the four parts into which they are divided by means of a horizontal percolation through a thin bed or layer of course sand or gravel. The construction of this building is good, and was made regardless of cost. At the north end of the last division is situated the mouth of the conducting main, whence it extends with an internal diameter of eighteen inches until it reaches the city; there the original main was reduced to fourteen inches. The total length of the aqueduct is 7,500 meters, and the fall from the surface of the water on the filters to the main pipe in the city is 22 meters.

Thus the city of Havana obtained the following important advantages as compared with the old system of supply,—*viz.*, economy, greater facility of distribution, and a water freer from impurities; however, no advantage was obtained in the matter of pressure or of quantity and quality of the water. In this second aqueduct the supply was calculated for a future population of a million inhabitants, with a daily supply of 40,000 cubic meters, but the main of 11 inches interior diameter yielded only 3,850 cubic meters daily, which, at the rate of 30 gallons for each inhabitant, provided for only about 38,500 persons,—that is, for a population about two-thirds smaller than that of Havana at that time; and this without taking into consideration

the loss of at least one-quarter of the gross supply through leakage and other causes. This defect was partially remedied by substituting for the 11-inch main a main 14 inches in diameter, interior measure; but, on account of the limitation fixed by the established descent, only 5,300 cubic meters daily were obtained, or enough for a population of 53,000. At that time the city of Havana had 150,000 inhabitants and 13,000 houses, so that not more than 2,500 house mains could be furnished to the capital, which, on account of its geographical situation, its magnificent harbor, and its commerce, increased in population to 250,000, besides a floating population of 20,000. It was compelled to remain in this miserable and unhealthy condition until the Vento canal was completed; a long and painful period two-thirds of the population being, so to speak, compelled to live thirsty.

It is a well-established fact that among the questions most closely allied to public order, health, development of wealth, and the physical welfare of the citizen, there are few of such importance and utility as is the abundant supply of pure water. In a city like Havana, where a hot climate is experienced and where the construction and the alignment of the streets are old-fashioned, the matter assumes still greater importance, especially since the city is destined to become a great center, because of its geographical relations to the wealth and commerce of the country.

The projector of the famous Vento aqueduct was Mr. Francisco de Albear y Lara, a native of Cuba, member of the engineer corps of the Spanish army, and otherwise an eminent man, having distinguished himself by his great learning exhibited in the direction and carrying out of many other important engineering works. Among these may be mentioned a system of drainage of swampy lands, and others for the disposal of sewage, which obtained the first prize in the Universal Exposition of Philadelphia; he also obtained a similar medal for the Vento aqueduct at the Amsterdam Exposition.

In a learned pamphlet, an excellent treatise upon the broad subject of city aqueducts, Mr. Albear showed the urgent necessity of furnishing Havana with a perfect supply of water, and proposed to utilize to that end the wonderful Vento springs, which emerge most abundantly from the very banks of the Almendares river, at the foot of the hills called del Barco, a distance of nine miles from the capital. The waters of these springs were formerly lost in the several rivulets and valleys tributary to the river.

In this pamphlet, published in 1856, the necessity for constructing the important work we are about to describe was clearly pointed out to the government. For a distance of about three miles on both banks of the Almendares river, and especially on the left side, there

emerge at the base or foot of the mountain a number of springs of varied volume and strength, from the tiniest jet to the mighty stream which, like another river, cuts its path through the heart of the mountains. There was one group which, above all, burst in great abundance from twenty different places within a small space at the foot of the hillside, and, gathering in one compact volume, fell like a cascade of diamonds into the Almendares river, causing its current to swerve to the opposite bank. These waters, always clear, pure, transparent, crystal-like, and palatable, maintain this same temperature in all seasons of the year; that is to say, they are cool in summer and warmer than the air in the cold winter days.

The great volume and force of the outflow led some to suppose that they had their origin in the filtration of the great Ariguanabo pond, or were fed from the San Antonio river, which emerges at the foot of a big ceiba tree; these sources being at a distance of thirty miles from each other, Mr. Albear demonstrated the lack of foundation for these conjectures, giving as his reason the fact that the streams had maintained the same height and rate of discharge ever since their discovery, whereas the pond and the river had diminished in volume many times, occasionally to the extent of becoming almost dry; he believed the springs to have their origin in the American continent, and, in conclusion, he showed the absolute assurance of their never-failing supply, unless there should occur some great upheaval which could affect the existence of the springs.

The quantity of water which the Vento springs produce is such that they could simultaneously supply such cities as New York, Philadelphia, and Chicago, should the proper works to that end be devised.

Its palatability is shown by the following analysis made by the eminent chemist, Dr. José Luis Casaseca.

Substances contained in the water.	grammes per litre.
Carbonate of lime	.1280
Carbonate of magnesia	.0257
Carbonated oxid of iron	.0053
Silicate of iron	.0053
Sulphite of lime	.0277
Chlorid of sodium	.0667
Extractive organic matter	.0050
Total	.2637

The most important feature of the Vento aqueduct, and that which is of itself enough to have established the reputation of an en-

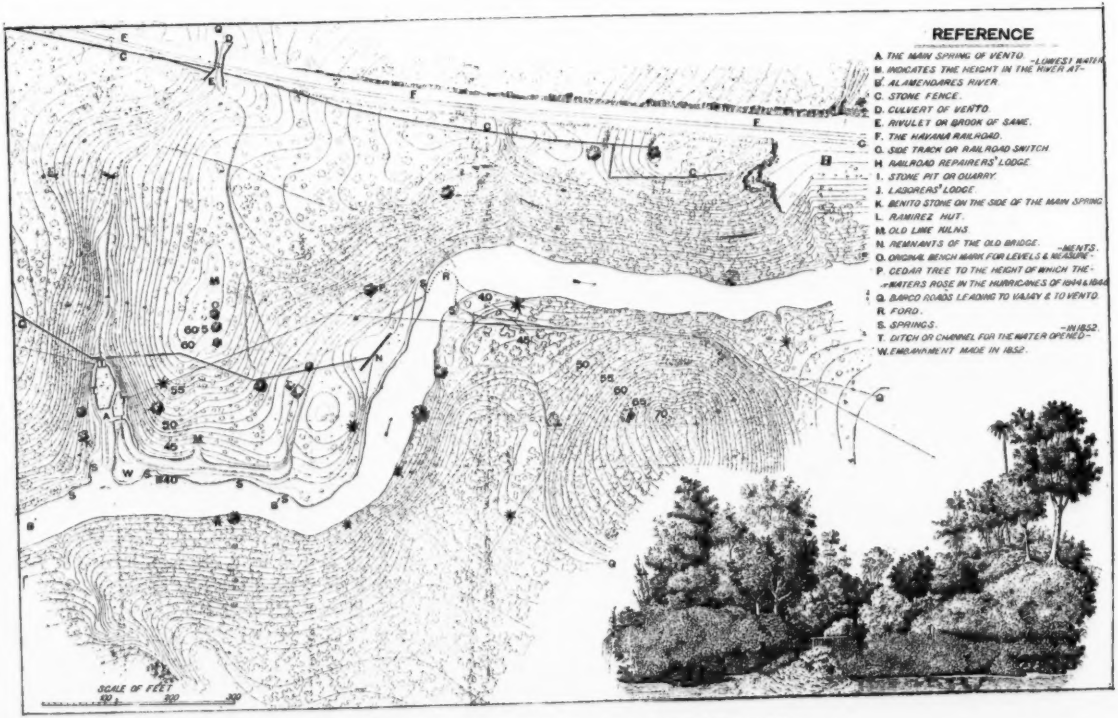
gineer, is the gathering of the innumerable springs to a common point of storage, the conducting thence of the requisite volume of water to the place of consumption, and discharging the surplus into the river.

This construction presented the greatest difficulty, owing to the topography of the land and the proximity of the river. It seemed as if nature had conspired to place as many obstacles as one could well conceive in the smallest possible space, to render well-nigh impossible the carrying out of an hydraulic work of such magnitude.

The springs are situated at the bottom of a funnel formed by high mountains, and, when the river rises, though ever so little, it becomes equal in height to the springs, and actually covers them completely, the marks of the outpouring of the pure and limpid waters being clearly seen in the midst of the dirty and turbulent waters which flood the main channel at such times. The ordinary discharge channel of the springs itself constituted another inconvenience, because in the rainy season a great torrent descended through it, having no other outlet. The very nature of the ground, being a Jurassic limestone formation, crannied and having innumerable empty spaces through which the water easily escaped as soon as their course was slightly modified, rendered more difficult the execution of the work. Every problem has been solved with the greatest wisdom and professional skill; the water of the spring is gathered in a great ashlar masonry and cement cistern, which forms the bottom of the natural funnel of the hillsides, and is completely isolated from the waters of the river; the *débris* coming from the overflow of the rivulet or brook is directed separately into the main stream. The waters from the springs are elevated to their proper level by simple accumulation, and their conduction to the city is thus rendered easier and more economical.

A great gate or dam closes this storage reservoir, the surplus being discharged by means of underground galleries into the river.

The separation from the waters of the river is effected by means of an elevated dike of sufficient thickness to resist the violence of the floods, which sometimes attain a height of eight meters. It forms one side of the storage basin, and thus serves a double purpose, by holding the spring waters and making them rise to a determined and convenient height, so that they may reach the city by gravity and supply the highest building without the use of any motor. In a word, in the first and most important part of the construction of the aqueduct have been overcome the greatest difficulties of the ground, by lowering the foundations of the dam, the dike, and the retaining walls of the hillsides, until the different streams of surface water are cut off, and all the water of the different springs is gathered in a single uncovered reservoir, protected from the overflowing of the river by means


REFERENCE
A. THE MAIN SPRING OF VENTO. —LOWEST WATER
M. INDICATES THE HEIGHT IN THE RIVER AT—
W. ALAMENDARES RIVER.
C. STONE FENCE.
D. CULVERT OF VENTO.
E. RIVULET OR BROOK OF SAME.
F. THE HAVANA RAILROAD.
G. SIDE TRACK OR RAILROAD SWITCH.
H. RAILROAD REPAIRERS' LODGE.
I. STONE PIT OR QUARRY.
J. LABORERS' LODGE.
K. BENITO STONE ON THE SIDE OF THE MAIN SPRING
L. RAMIREZ HUT.
M. OLD LIME KILNS.
N. REMNANTS OF THE OLD BRIDGE. —MENTS.
O. ORIGINAL BENCH MARK FOR LEVELS & MEASURE—
P. CEDAR TREE TO THE HEIGHT OF WHICH THE—
—WATERS ROSE IN THE HURRICANES OF 1844 & 1846
Q. BARCO ROADS LEADING TO VALLEY & TO VENTO.
R. FORD.
S. SPRINGS. —IN 1852.
T. DITCH OR CHANNEL FOR THE WATER OPENED—
W. EMBANKMENT MADE IN 1852.
SCALE OF FEET
100 200 300

TOPOGRAPHY OF THE VENTO SPRINGS AND SURROUNDINGS.

of the dam, from the torrents of the brook by a special channel, and from the *débris* of the heavy rains on the hillsides by means of efficient crowning ditches.

The surface overflow is so arranged that the discharge channel terminates in the most convenient place possible in the direction of the river's course, while it is impossible for the back waters from the river to enter the reservoir, even in times of extraordinary floods.

The cost of this part of the work was $280,403. The second part of the work, no less admirable in its execution, is that which relates to the designing of the aqueduct.

The springs are situated on the left bank of the river and the suburbs of the city on the right, the country lying between them for the first 5,000 meters being broken by a succession of hills extending from east to west, bordering the course of the Almendares river and giving rise to innumerable small streams and swampy rivulets.

Far beyond the hills continue, forming a broad basin, in the center of which is a swamp surrounded by high hills in the suburbs of the the city. The land about the spring abounds in fossiliferous lime stone, but its character changes at the foot of the Barco Heights, which, for a distance of more than 2,000 meters, form a bank of stratified sandstones so soft that the heavy rains break them to pieces. Then follow the lands of the swamp, and then the hills near the suburbs in which the lime stone is again to be found.

The first work of the engineer was the question of crossing the river. It could be effected by crossing to the opposite bank immediately at the spring by following down the left bank to a distance beyond the mountains, or by crossing at an intermediate point, near the fork of the road from Barco to Vajay.

The first was deemed inadvisable, inasmuch as there was little room for the necessary gate-houses and other works, and the excavation would weaken the narrow strip of land separating the springs from the river channel; the second involved topographical difficulties, and would bring the aqueduct in dangerous proximity to the railroad and its attendant tremor of the ground.

In order to accomplish the third and adopted scheme, the engineer considered three plans: first, to construct a bridge of seven segmental arches, the center arch having an opening of 15 meters and the side arches respectively 12½, 10, and 7½ meters, which would receive a syphon, the upper part of which would not be above the level permitted by the limitations of the atmospheric pressure in raising the water; second, to place in the bottom of the river inverted syphons (a construction, however, which does not afford the desired safety for a Cuban city aqueduct, because of the impossibility of superintending

and repairing it with ease and promptness); third, the construction of a tunnel under the river and the hill on the opposite side.

This last, though somewhat more expensive, was the plan adopted, on account of its many and great advantages, and carried out with skill and success. In this manner were laid with absolute safety the pipes of the syphon, thus facilitating the inspection, repairing and renewing of the parts as required.

The tunnel may be easily entered by means of broad and commodious stairs; the walls and vaults do not show the least trace of humidity, this being the feature which excites the greatest admiration of all visitors, especially when the employees permit them to view the operation of opening and closing the gates and to see the current flowing from the springs and pouring like a cataract, at the mouth of the syphon where the channel proper commences.

The excavation measures 4,258 cubic meters; the vault is made of brick masonry and hydraulic mortar, its total cost being estimated at $372,466, including the gate-houses, valves, and machinery situated at both entrances of the tunnel.

The aqueduct proper commences at the tunnel, and is laid out in straight stretches alternating with curves in arcs of circle, the radius of which is never less than 200 meters, whereby the bends are eased and reduction of flow and the speed avoided. All the topographical difficulties have been admirably overcome in the plan adopted, and a great ultimate economy has been achieved in the construction.

The total length of the line from the Vento springs to Jesus del Monte, in the suburbs of Havana, is 10,800 meters.

The masonry aqueduct was decided upon, in preference to other means of conduction, because iron pipes would both be more expensive (for an equal volume of flow) and occasion greater loss of head and greater maintenance expense, while an open canal would not so well conserve the purity and freshness of the water, and would, moreover, involve considerable loss from evaporation.

The conduit proper is one meter in depth and two in breadth; the bottom is an inverted arch, with a rise of one-tenth of a meter, and a thickness of one-half meter; the sides have an outward slope, on the inner face, of ten centimeters per meter, being .75 meter thick at the bottom and .65 at the top.

The conduit is covered by a circular arch, with an internal radius of one meter and an external radius of one and four-tenths meters, brought down with uniform thickness to the spandrils and thence extended by tangent planes to the exterior of the side-walls.

The aqueduct has a uniform slope of .0003 per meter, or one in 3333. This gives the water a flow of .6 meter per second, and the

consequent supply delivered is 72 cubic meters per hour, or 103,680 cubic meters (about 27,500,000 gallons) per day.

The method of construction avoids any necessity for frequent repairs or alterations; the water is not exposed to loss by evaporation, but is in sufficiently free contact with air through the ventilation afforded by ventilating and observing towers, constructed at proper intervals, through which also any needed access may be had for inspection or examination.

This part of the work was estimated at $1,280,853, and both the aqueduct and works at Vento were devised and constructed under the direction of the engineer, Albear y Lara, who did not, however, enjoy the satisfaction of seeing them finished.

Later on, and under the superintendence of another engineer, Joaquin Ruiz, and a North American construction company, the grand reservoir was built, description of which is omitted, as its form and system are similar to those generally established in this country.

The construction of the aqueduct described above was a work of many years. It was projected in 1856, but not commenced until 1860; the penurious disposition of the administration was the cause of many interruptions. Albear, nevertheless, had the good luck to see coming to the city a part of the waters from the springs that had been imprisoned by connecting the canal through a temporary connection to the iron pipes of the old aqueduct, and only five years ago the city of Havana began to enjoy the incalculable benefits of this magnificent work, the total cost of which has reached the sum of $6,000,000,—owing wholly to the stoppages and interruptions encountered in its construction, for lack of funds, and the mistakes of the administration, and in no wise to any error of the builder, who made his projects, estimates, and plans with the strictest accuracy. Even at this very day the work of the canal, of the reservoir, and of the distribution apparatus, finished as they are in every detail, do not give the results which might be expected, because the setting of new and larger pipes has not been completed. Those of the old San Fernando aqueduct, which were laid from 1835 to 1855, are utilized, many of them having been used for sixty years and lacking the necessary diameter. The pressure of the water destroys them easily, leaks are plentiful, and the supply and head are thus diminished.

The name of Albear, to whose talents and labor the realization of the project is due, will be honored as long as the aqueduct exists, as one of the most illustrious benefactors of the community. A marble statue erected to his memory on Monserrate square, at the very center of the city, bears witness to the gratitude of the people.

THE POSSIBLE AND THE IMPOSSIBLE IN ELECTRIC DEVELOPMENT.

By Wm. Baxter, Jr.

IT is very generally believed by laymen that our knowledge of electrical science is so meager that we are wholly at sea as to what the development of the future may be. So strong is this conviction that any assertion as to the possibility of accomplishing the most unheard-of things is accepted as strictly within the bounds of reason. Nothing, however, could be further from the truth than such notions, for, as a matter of fact, we are no more in the dark in respect to electrical science than to any other. We cannot say that we have mastered the subject from A to Z, nor could such a claim be substantiated in any department of science. We can truthfully say, however, that the electric field is as far advanced as any other.

There are a great many things possible that have not yielded to the efforts to reduce them to a practical form, and there are a great many other things supposed, by the uninformed, to be possible that never will be reduced to the practical form, simply because they are impossibilities. The knowledge we now possess of science in general enables us to separate the attainable from the unattainable, in the theoretical sense; but we cannot make such a classification as to practical results with the same degree of accuracy, owing to the fact that we cannot judge with certainty as to the possibility of overcoming obstacles not yet encountered. In consequence, we are able to decide with certainty only as to what is impossible, and therefore can never be accomplished; as to the possibilities we can only say that they are such theoretically, but practically may be beyond realization, on account of our inability to remove obstacles.

This statement may appear inconsistent to those in the habit of considering that a result can or cannot be accomplished, but a little reflection will show that so complete a process of differentiation can be applied only in a limited number of cases. For example, we can say without hesitation that a man cannot jump over the Hudson river, since the act is a physical impossibility, implying a controversion of the laws of nature; but we cannot speak with the same certainty with regard to an effort to fly across. We know that there is no theoretical barrier in the way of accomplishing this result, but we also know that the practical difficulties are very great, and have not been overcome; whether they ever will be is a matter of pure conjecture.

A positive knowledge of what can be accomplished in the future would be of the greatest value, as it would enable us to shape our actions accordingly; but, this degree of certainty not being within our reach, an approximation to it may be regarded as desirable. An investigation that will determine just where we stand may serve to show that in reality we are very nearly as well off as we would be if all uncertainty were removed.

Since the impossibilities can be pointed out with certainty, it will be well to consider them first,—especially as it is in relation to these that the most absurd notions prevail, the greatest number of impractical schemes being brought forward to captivate the too confiding investor.

It is not an uncommon thing to hear of some one who has invented a simple mechanical contrivance whereby the light obtainable from a given amount of electric energy can be doubled; or of an electric motor that will greatly increase the output; or of a generator that can furnish current for several times the number of lights now obtainable from the same engine-capacity. The power-station of electric railways has several times been threatened with extinction by inventions in which it was proposed to mount a dynamo on one axle of the car and a motor on the other, the former to be rotated by the motion of the car and thus furnish current to operate the latter, the car being driven by the power thus developed. As it is evident that the dynamo would not generate a current until set in motion, and that the motor would not give any power until supplied with current, and the car would not move of its own accord, the difficulty of starting has, in almost every case, been provided for by adding a small storage battery to furnish the starting current, the latter being recharged by the dynamos when the car is in motion. To the engineer all these schemes look so absurd that it is almost impossible to believe that they can be considered as anything more than a huge joke, but, as a matter of fact, they are regarded seriously by many capitalists. Their inventors are, in most cases, unprincipled charlatans, who live by foisting fraudulent schemes upon the public; but in some instances the inventors are the victims of their own ignorance.

If science were in as crude a state as it was at the beginning of the century, we might not be able to determine with certainty whether such devices are possible or not, but our knowledge of the laws of nature at the present time is such that there is no room for doubt. To put the matter plainly, we know that, when we transform electric energy into mechanical, nothing is gained or lost by the operation, and the same is true of the reverse process. We know this, because we can measure energy, in its various forms, just as easily as the grocer

can weigh a pound of lard, and with far greater accuracy. Those who honestly believe that they can discover some way whereby a motor may be made to drive a dynamo and the latter to furnish current for the former, and a surplus to use for lighting and other purposes, may be surprised to learn that this arrangement of machines is used for the purpose of testing their efficiency, by many manufacturers, and that the amount of extra current that has to be supplied from an external source to keep the combination in motion serves as a measure of the efficiency of the machines. When two machines of the same design and size are connected so that one acts as a generator and the other as a motor, the demand of the latter for current is greater than the former can supply, and the difference, which must be provided from an independent source, will vary with the efficiency, but will always be a considerable quantity. To wipe out this deficiency and replace it by a surplus is simply beyond the limits of physical possibility.

Electrical machinery has not been developed to such a state of perfection as to justify the assertion that motors and generators, as mechanical structures, cannot be improved upon. It cannot be doubted that in the future many weak points of the present designs will be eliminated. But the room for improvement in these machines, as transformers of energy, is so small that it is actually unworthy of consideration. For every ten units of mechanical energy we put into a generator we can recover nine or nine and a quarter of electric energy, and, conversely, for every ten units of electrical energy put into a motor we can get nine, or a little more, of work. Inasmuch as the total loss is not over ten per cent., it follows that those who expect the future to bring great, or even noticeable, improvements in this line will be doomed to disappointment.

When we pass from machinery to other branches of the electrical industry, we at once step into a field of uncertainty, not as to theoretical possibilities, but as to practical results. As an illustration, take the storage battery. There are many men who expect that great results will be accomplished in this direction, and that they may come at any time. In theory these views are justifiable, although there may be a considerable difference of opinion as to the actual value of even the best theoretical attainments; how near to perfection we may arrive in the future it is impossible to predict. The room for improvement in this field is undoubtedly very great, as it is wholly within the limits of theoretical possibilities for the weight of the batteries to be reduced to a small portion of what it is to-day; furthermore, there appears to be no reason why the durability should not be increased. The actual weight of the material that takes part in the chemical action upon which the storage battery depends is about twelve pounds

per h. p. hour of energy stored, and this is about one-tenth of the weight of the batteries now made. As the cell and the frames that hold the active material must weigh something, it is not possible to reduce the weight to the theoretical limits; but this point can be approached, and it would not seem unreasonable to assume that a reduction to twenty-five or thirty pounds per h.-p. hour will eventually be accomplished. This alone, however, would not necessarily be an improvement, because the internal resistance might be so great as to render it necessary to work the battery at a very low rate of discharge, so as to obtain a fair efficiency. The reduction of weight would be a valuable improvement to the storage battery, as it would make its use possible in many kinds of traction work; but lightness with respect to storage capacity would not mean a reduction of the weight of batteries that would be required to operate a car or vehicle, unless accompanied with a high discharge rate. If the discharge rate were low, as it would be with high internal resistance, a large number of cells would have to be carried, and the only advantage derived would be that a greater distance could be covered with one charge. For all classes of stationary work, the most important point is the durability, and, when improvement in this direction has been carried far enough, the storage battery will become very useful; but, for it to obtain a foothold in other fields, where the energy of the battery must be used in part to transport its own weight, improvements must be made, not only in durability, but also in the size and weight. We know that such improvements are possible, in theory, but who can say that they are in practice? Therefore, who can say that the storage battery will, or will not, be perfected to such an extent that it will be used for other than stationary purposes? There are many who have a very strong conviction that it will, but only time can tell whether the ingenuity of man will be able to overcome the obstacles. If they should be removed, the horseless-carriage problem would at once be solved, and the sphere of usefulness of the storage battery would be largely increased.

Of all the great achievements that electricity is supposed to have in store for the future, the perfect primary battery is generally regarded as the most important. So much has been said about the direct production of electricity from coal that every one is more or less familiar with the subject, and the belief commonly entertained is that the solution of this problem would send the steam engine into the scrap-heap, and completely revolutionize the industrial affairs of the world.

If a coal-consuming battery could be made that would come up to the ideal of those who dream about its possibilities, it, no doubt, would accomplish this result; but the actual results of the future, if

any are ever realized, may be very different from these dreams. We know that the chemical action between carbon and oxygen will liberate energy, and therefore, so far as this action alone is concerned, we can say that the coal battery is a theoretical possibility; but the efforts that have been made to overcome the difficulties that beset the problem have so far failed. In order to be able to obtain electric energy from any chemical reaction, it is necessary that the heat set free shall be more than that absorbed, or, in other words, the thermochemical reaction must be positive; with carbon this condition can be fulfilled, but, in addition to this, it is also necessary that the materials used be conductors of electricity. While coal can meet the first requirement, it fails in regard to the second,—that is, it is not a conductor; hence, before it can be made operative, it must be so changed that it will admit of the free passage of an electric current; else the chemical action must be brought about by some indirect process. We, therefore, see that, in the very start, we meet a formidable stumbling-block. This, however, is not the only one, and perhaps not the most formidable one. In all the batteries with which we are familiar the active material forms a part of the apparatus, and is destroyed by the process of generating the current. This can be tolerated in the small batteries of the present time, because the work they do is almost insignificant, and therefore the expense occasioned by the destruction of a part is not an important item; but this would not be the case with an apparatus intended to compete with a steam engine and boiler. To consume the coal part of the battery and be compelled to renew it continually would be about equivalent to making the grates of a boiler of coal, and replacing them as fast as they burned up.

Unless the battery can be made so that the coal can be fed into it as it is into a boiler, it seems that the prospects of obtaining energy at a low cost in this way are not very great. This point was very ably presented by Mr. C. J. Reed, in a series of articles contributed to the electrical journals a short time ago.

Should all the foregoing difficulties be overcome, the value of the battery would depend upon its form. If compact and light, it would be of the greatest value, but, if large in proportion to the output, it would find only a limited application. If light and compact, it could be used to operate locomotives, and thus do away with the power-stations, trolley lines, and feeders. It could also be used to propel boats of every kind, and to furnish power in all cases where the steam engine is now used; and, as the conversion of chemical energy into work, through the electrical channel, can be effected with greater efficiency than through the thermic chain, owing to the inevitable losses

in the latter, it would naturally follow that the electric motor would replace the steam engine for all purposes. If, however, the battery could not be reduced to a light and compact form, the best it could do would be to replace the stationary steam engines, and, therefore, its sphere of usefulness would be greatly reduced.

Thus we see that, while the solution of the primary battery problem is theoretically possible, we are unable to say that it is practically so; nor can we determine what its value would be, owing to the uncertainty as to the form of the solution.

For several years the problem of producing light without heat has received considerable attention, and the work of some of those who are engaged in that field has come prominently before the public during the past few months. This is another of those theoretical possibilities about which we can make no positive predictions. In all the various processes by which we now obtain light, the greater portion of the energy used for the purpose is converted into heat, and, therefore, lost. As energy in its different forms is transformable, and as in other transformations we recover a far greater percentage than in the case of light, there seems to be no reason why far better results should not be obtained in the latter field. The margin for improvement is very great; in fact, the best we can do, now, is to convert about eight or ten per cent. of the applied energy into light, this result being obtained in the electric arc light. In the incandescent light we can recover only about two per cent., and in gas light still less. In view of these facts, it cannot be regarded as unreasonable to believe that better results will be accomplished in this direction; but the progress of the past does not justify the assumption that these results will be realized in the very near future, and, further, we cannot say that, when realized, they will be of practical value, for it may be that the mechanism required to operate the lights will be so complicated or frail as to offset all the advantages.

A review of all the points here presented will show that the line of demarcation between that which we know to be possible and that about which there is uncertainty is not very far in advance of the actual accomplishments. From this it might be inferred by many that we can speak with certainty only about that which has been done, and that, as regards anything beyond, we are wholly at sea. This, however, is not so; we are not at all in the dark as to the theoretical aspect of any case that still baffles our ingenuity, but, having failed to remove the difficulties that stand in the way of the solution of these problems, we are not in a position to say that we know whether they will be removed in the future.

REVIEW OF THE ENGINEERING PRESS

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National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6*s.* 6*d.* London.
Popular Science Monthly. *m.* $5. New York
Power. *m.* $1. New York.
Practical Engineer. *w.* 10*s.* London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Progressive Age. *s-m.* $3. New York.
Progress of the World, The. *m.* $1. N. Y.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7*s.* London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5*s.* London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10*s.* London.
School of Mines Quarterly. $2. New York.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. New York
Scientific Machinist. *s-m.* $1.50. Cleveland, O
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technograph. *yr.* 50 cts. Urbana, Ill.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $3. Butte, Mon.
Western Railway Club, Pro. Chicago.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.

ARCHITECTURE & BUILDING

Design, Construction, Materials, Heating, Ventilation, Plumbing, Gas Fitting, Etc.

Building-Stones.

THE importance of carefully testing the durability of building-stone before deciding upon its use is well exemplified in the United States by the present condition of many buildings not yet more than half a century old,—some of them not even fifty years old. The *Bulletin of the Pennsylvania State College* has recently taken up this subject, and has shown that mere strength is not, of itself, an evidence of durability in a building-stone. *The Architect and Contract Reporter* (Aug. 7), reprinting the article from the first-named publication, coincides with this view. No quality of beauty, ease in working, or other desirable characteristic in a building-stone can compensate for lack of lasting quality. The climate of the United States is in many parts very severe in its effects upon some kinds of stone that will last for centuries in milder climes. Thus the obelisk in Central Park has probably suffered more during the short time since it was placed there than during a couple of centuries on the dry, warm Egyptian plain from which it was brought.

Now, the weathering quality of different kinds of stone, or of different specimens of the same kind of stone, can in many cases be known only by careful testing. The article here reviewed says truly that "no rule can be announced other than that suggested by a knowledge of the chemical solubility of the several rock elements. Feldspar is readily transformed into various products of decomposition, and hence is an undesirable element of building stone. Orthoclase weathers less readily than oligolase. Quartz is wholly unaffected by weathering agencies. Sandstone and quartz conglomerates cemented by silicious material are not rapidly disintegrated. The only sure test of the comparative durability of a stone is afforded by its appearance *in situ*. A rock which at the quarry stands out in relief as a conspicuous feature of the country, and whose edges are sharp and true, will furnish good durable stone. Particularly is this true if the rock masses, weather-beaten and fire-swept for ages, still show fresh faces. A stone of hard, close, fine-grained texture and impervious to moisture has a comparatively long endurance. Basalt is the most obdurate to atmospheric influences. One of the best indications of the durability of stones is afforded in the porosity of the stone as measured by the amount of water absorbed by it after immersion for twenty-four hours."

Weighing will easily show the amount of absorption, if the weight before immersion be known. Percentages of absorption for different kinds of stone are stated:

PER CENT. OF ABSORPTION.

	Maximum.	Minimum.	Average.
Granites	0.66	0	0.13
Marbles	0.66	0	0.33
Limestones	5.0	0.20	2.63
Sandstones	6.66	0.41	4.16
Bricks	25.0	2.0	10.0

After stone has absorbed water, frost has a powerful disintegrating action upon it, through the expansion of the contained water in freezing; this action is more pronounced with stones containing soluble substances. Such stones exfoliate; laminar stones split, the freezing water acting like a powerful wedge. The testing of stone is thus described:

"The action of frost may be imitated by the expansive action of a crystallizing substance. A specimen of known weight is immersed in a boiling concentrated solution of sulphate of soda for thirty minutes; it is carefully withdrawn and suspended in a cool, dry place over a dish of the solution. An efflorescence soon appears, when the dish is again brought up to redip the specimen. An exfoliation again appears as the solidifying salt breaks off some material from the faces. After

repeating the process during a week's time, the sediment is weighed and computed as an indication of the like effect of frost. A porous stone which absorbs a great deal of the salt secretes a great bulk of solution, and, unless it possesses strong adhering qualities, will yield to the expansive action of the crystallization in like manner as to the destructive action of frost.

"By this means it has been discovered that the life of common brown stones varies from 5 to 25 years; of fine brown stones, from 15 to 40 years; of compact sandstones, from 100 to 250 years; of common limestones, from 40 to 200 years; of marbles, from 60 to 500 years; of granites, from 75 to 600 years; of gneiss, from 100 years to many centuries.

"As an example, by immersion the stone selected for the capitol at Washington was found to produce an amount of sediment after fifty dips, and an inch cube lost 0.315 ounces of its weight. From these data it was estimated that natural freezing would exfoliate this particular stone to a depth of 1 inch in 10,000 years."

Chemical and physical causes, other than weight supported, are the more important factors in the failure of building-stones. Very few kinds of stone in buildings are destroyed by crushing, if their weathering qualities are good.

Art-Smithing in Germany.

IN art-smithing (according to *The British Architect*, Aug. 14) Germany affords a field of study unlike that found in any other country. In the thirteenth century Germany began to develop characteristic features in art metal-working. The divergence from previous styles consisted in "elegant branching strap-work, ending in little *fleur-de-lis* and vine leaves," which, though a French style, yet showed a marked variation from the French treatment. This divergence became more and more pronounced during the next two centuries, "resulting in rich and characteristic foliated ornament based on the vine, mingled with *fleur-de-lis* and tracery forms." In an introduction to the English edition of Professor Charles Sales Meyer's "Handbook of Art-Smithing," Mr. B. T. Batsford sets forth the facts above stated, and adds that in the fifteenth century, at Cologne, a new style of work appeared based on the thistle. This new style "held the field until supplanted by the renaissance ornament."

Mr. Batsford says that "of designers of ironwork, as designers, there were probably none, the master smith setting the task and directing the work on strictly traditional lines, with such modifications only as the moment suggested. The work may, in most cases, have been produced without drawings, for ironwork designs followed certain definite lines of precedent, which might be modified within limits, but were not departed from. Thus grilles were often worked from a center of more or less complexity, with the loose ends of bars finishing in traditional floriated ornament. Progress was mainly, if not wholly, confined to increasing the technical difficulties to be overcome by the smith. Not an illustration or drawing of any scrap of blacksmith's work, drawn for its own sake, has come down to us,—a fact most remarkable in an age so prolific in studies and designs for the work of the gold and silver smith. Those among us who desire to see this state of things re-established among the craftsmen of the present day cannot do better than study attentively the progressive development of German ironworking, from the close of the medieval period until the style known as baroque began to change the current of smithing.

"The new style came from across the French frontier and spread eventually over a large part, if not the whole, of Germany, changing the character of the design and modifying considerably all the traditions of the smith's craft. It was, however, but a mere wave of fashion compared to the overwhelming change wrought by the rococo, which followed and swept away every landmark of the smith. The lilies and passion-flowers, the tricky interlacings, threadles, and spirals which have been his peculiar pride, and the round bar itself disappeared at once, only to reappear in our own times. Highly-trained professional designers became indispensa-

ble, numbers of pattern books were published in imitation of the French, and the smith as creator and designer became extinct. The individual fancy of the workman in Germany could in future only be indulged, if at all, to the most limited extent. The designs were essentially French, but modified in the directions both of extra richness and less restraint. Though the skill and smithcraft in the finer examples is simply superb, the names of the smiths who produced them are never, unless accidentally, recorded. Whether this complete revolution was for good or ill is a debatable question."

Harmonizing Painted Glass with Other Details of Buildings.

THE fault of using painted glass in violation of good taste is more conspicuous in private than in public buildings, though in the latter may be found here and there egregious instances wherein incongruity is the most pronounced effect of an attempt to beautify by this,—when ably treated,—one of the most effective means of decoration. Doubtless the use of stained and painted glass should always be under the direction of cultivated taste. The fact is that it too frequently is the subject of the caprice of inartistic people,—building committees, etc.,—who are in no sense competent to decide where its employment would be sanctioned by the rules of art, but who must have it because it is the fashion; and who must have the same colors and patterns they have seen elsewhere, whether adapted to the proposed environment or not.

Architecture and Building quotes with approval (from a writer in *London Architect*) some sensible remarks upon the harmonization of glass paintings with associated architecture and sculpture. Without dwelling upon what is said of the subjects and treatment of glass paintings in their adaptation to different buildings, such as churches, libraries, etc., we pass to remarks comprehensible, not merely to professionals, but to all intelligent people.

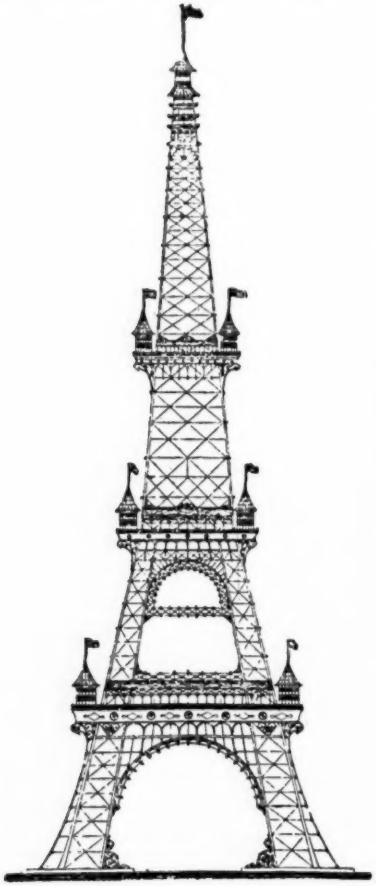
"If the interior of the building, or even the particular situation of the window, is dark and obscure, the glass painting ought to exhibit a predominance of deep hues; if the church or situation of the window is light in effect, a lighter cast of color would be preferable in the painted glass. If the character of the architecture is cheerful, the tone of the glass painting should be warm; if sombre and melancholy, the tone of the glass painting should be cold. Thus, buildings having dark interiors, by reason of their architectural construction (for additional gloom produced by the presence of painted glass is a circumstance quite beside the question), such as Westminster Abbey or St. Paul's Cathedral, would require more powerfully colored glass paintings than the Temple Church, or St. Clement Danes in the Strand: but, inasmuch as the character of Gothic architecture is somber and melancholy compared with that of the Italian, glass paintings designed for Westminster Abbey, or the Temple Church, should be colder in tone than those designed for St. Paul's or St. Clement Danes respectively. In like manner, painted windows situated in the dome of St. Paul's, or in the round part of the Temple Church, might require to be more deeply colored than painted windows in the choir of St. Paul's or in the choir of the Temple Church; yet the tone of coloring that would harmonize with any part of the Temple Church would be colder and more grave than that which would suit any part of St. Paul's Cathedral.

"It need scarcely be added that the details of a glass painting designed for St. Paul's Cathedral, or any other Italian church, should be of Italian character; or that the details of a glass painting designed for Westminster Abbey, or the Temple Church, should be in conformity with the details of those buildings respectively, and should in all other points be as advanced in point of art and general excellence as the architecture and sculpture are."

The author thinks that the harmony between Gothic architecture and coeval Gothic picture glass painting is not as complete as is generally supposed, although Gothic pattern glass painting harmonizes completely in the majority of cases.

The Chicago Tower.

NOT content with being the homestead of tall building, Chicago, like ancient Babel, wishes to have the highest artificial structure on the face of the earth. Nothing less than 1,115 feet in height will satisfy the passion of the Chicago people for looking down upon the inhabitants of



other cities. A tower of the height named is not only projected, but, *The Electrical Engineer* says, is in actual course of exploitation. Its cost is to be $800,000, and in external appearance it will be as shown in the engraving, reproduced from the journal named. If carried out as planned, this tower will be a great monument of architectural and engineering construction

The base will occupy a plot 326 feet square. "From the four corner supports, each of which is 50 feet square, will rise arches 200 feet across, and the same in height. These arches will support the first landing, which will have 90,000 square feet of flooring, where 22,000 persons can be accommodated at one time. There is a distance of 225 feet from the ground to this first landing.

"At a height of 450 feet there is to be a platform 150 feet square. Six hundred and seventy-five feet above the ground is the third landing, far higher than any building in Chicago. At an elevation of 1,000 feet above the earth is the fourth landing, and from there stairs lead up to the very top of the tower.

"Thirty-four elevators are to be used in this tower. They will be operated by electricity, the power being derived from the plant used in lighting the structure.

"The plan of having a United States meteorological bureau has been discussed at Washington and favorably considered by the officials of that department. The most important observations of all on such a tower would be those relating to atmospheric electricity. A few observations at the Washington monument have already shown some remarkable comparisons between the changes at that height and at the earth's surface. There is hardly a point regarding diurnal change, abnormal change, or seasonable change of meteorological element that would not be successfully aided by records from such a tower."

It appears to be supposed that people in and about Chicago (not having natural elevations of land from which to gaze afar, and satisfactory extension of view not being had from the roofs of the tall buildings hitherto available) will gladly part with their shekels for the privilege of being periodically lifted to the top of this structure, and that thus an income which will pay a fair profit on the proposed investment will be derived.

A revenue of considerable importance will also be derived from visitors to the city from various parts of the country, and from foreign travellers.

Corrosion of Lead Pipes.

THE corrosion of lead pipes may result from both internal and external causes. Speaking of the latter category, Mr. Oscar Kirby, in *Machinery* (London, Aug. 15), points out that lead pipes laid in trenches containing sulphate of lime in the material with which the trenches are filled (as from sweepings of floors in buildings where plaster of paris has been used in finishing walls) are liable to corrosion of an extent that may, and does, create leaks. If any of the fragments of the sulphate of lime come in contact with the pipe, the moisture in the filling condensing upon the outside of the pipe acts together with the sulphate to corrode the pipe. Also, atmospheric changes produce moisture upon the outside of a pipe, when built into walls, and this moisture combined with the lime will corrode the pipe and cause it to leak. The corroded parts of the pipe are generally covered with a red incrustation where honeycombed or eaten through. Yellow and red clay and peaty soil corrode lead pipes slowly, but blue clay and many kinds of sand will do so very quickly, and are the cause of much waste of water. The corrosion is different from that caused by lime, inasmuch as the surface of the pipe is eaten away without the formation of any incrustation. It is obvious that the corrosion of lead pipes from the outside, and the waste of water in consequence, can be guarded against.

So much for external corrosion. The lesson is plain; lead pipes should be isolated from sulphate of lime and other corrosive materials.

Internal corrosion is the result of acids, of which some water has present a notable quantity. In a paper read before the British Association, at its July meeting, the author exhibited samples of lead pipe very much corroded from this cause.

The samples attacked in this way were corroded all through the length. In pipes so injured fracture may occur at any point or at many points. Soft moor-land waters, which contain acid produced by decaying peat, act upon lead in this manner; but, if peat and other decaying vegetable matter are kept out of the impounding reservoirs, the acid is not produced, and, as a consequence, lead pipes are not acted upon.

Mr. Kirby says that, when service pipes are composed of English lead from which silver has not been separated, they resist the action of peat acid. He asserts that he has examined lead pipes which have been in constant use for thirty years, whose calibre and weight have been precisely the same when taken out as when they were put in, thus proving that no portion of the pipes had been washed away by acidulated moor-land water,—or, in other words, the water had no action upon them. As a substitute for good argentiferous lead, the pipes are frequently lined with tin about a millimeter in thickness; but in the production of tin-lined lead pipe the tin dissolves a considerable quantity of lead; consequently the lining is not pure tin, but a mixture of tin and lead; hence acidulated water drawn through these pipes and subjected to the sulphuretted hydrogen test distinctly indicates the presence of lead. As tin melts at a much lower temperature than that required in the solder by plumbers to make the joints in the pipes, it runs and fills the invert of the pipes, leaving them weak at the joints and partially filled up with tin. This accounts for the fact that these pipes so frequently burst near the joints. Of course they can be joined together with gun-metal cone connections without the aid of solder, but, inasmuch as the lining is an alloy of tin and lead, it does not effect the purpose intended. Tin-washed lead pipe has proved itself superior to the tin-lined lead pipe, the process of washing being done so quickly that there is not time for the tin to dissolve the lead. The washing is done by pouring molten tin into the pipe as it is forced through the die; the tin then washes against the inside of the pipe, and leaves a thin coat on the inner surface, and, if desired, the outer surface can be washed also. In joining these pipes the ends to be jointed should be filled for a few inches with table salt to prevent the tin-wash running when heated by the plumber's solder. The salt can easily be washed out of the pipes after the joints are made. Acidulated water drawn through these

pipes does not yield the slightest trace of lead contamination.

The tin-washed pipes are, therefore, considered as decidedly preferable to the tin-lined pipes. The author states that expert investigation of cases of lead-poisoning attributed to contamination of water flowing through lead pipes has very rarely failed to show that the poisoning was due to lead absorbed into the system from other sources, and that the pipes were innocent.

Walls and Ceilings as Related to Sanitation.

THIS topic was brought before the congress of sanitary inspectors at Oban last June, and the pernicious practice of papering walls layer upon layer, as is frequently done, was strongly condemned. Cases were cited where no less than fifteen layers of wall paper had been super-imposed. It was clearly shown that paper used in this way becomes a *nidus* for infectious matter, to say nothing of its being a harbor for a class of insects which do most of their travelling and exploration by night. Size-coloring, commonly called kalsomine, while not harboring insects, is also condemned as unsanitary. The most sanitary finish that can be applied to plastered walls is oil-paint, which admits of thorough cleansing with water without disfigurement. Some might object that this reduces the permeability of the walls to air, but in an otherwise well-ventilated house this is unimportant.

Guarantees for Heating Contracts.

THE State inspectors of Massachusetts have issued a circular to school committees which will doubtless influence the framing of guarantees for heating and ventilating school buildings in other States. In this circular the inspectors say: "In the ventilation of school buildings the many hundred examinations made by the inspectors of this department have shown that the following requirements can be easily complied with: 1. That the apparatus will, with proper management, heat all the rooms, including the corridors, to 70 degrees F. in any weather. 2. That, with the rooms at 70 degrees and a difference of not less than 40 degrees between the temperature of the outside air and that of the air entering the room at the warm-air inlet, the apparatus will supply at least thirty cubic feet of air per minute for each scholar accommodated in the rooms. 3. That such supply of air will so circulate in the rooms that no uncomfortable draft will be felt, and that the difference in temperature between any two points on the breathing plane in the occupied portion of a room will not exceed three degrees. 4. That vitiated air in amount equal to the supply from the inlets will be removed through the ventiducts. 5. That the sanitary appliances will be so ventilated that no odors therefrom will be perceived in any portion of the building. To secure the approval of this department of plans showing methods or systems of heating and ventilation, the above requirements must be guaranteed in the specifications accompanying the plans."

A Correction.

IN our last number in the article on "Pipe Chases," our able and much esteemed contemporary, *The Engineering Record*, should have received the credit which was erroneously given to *Engineering News*. The names of these two excellent papers are so nearly alike that a mistake of this kind, though regrettable, is natural, and we are sure *The Engineering Record* will acquit us of any intent to give credit to the wrong source.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Architecture and Building and Allied Subjects in the American and English Architectural and Engineering Journals—See Introductory.

Construction and Design.

*7603. The American Surety Building. Barr Ferree (An illustrated description giving much interesting information. The highest praise is given the architect for the beauty of the design, and the building is counted among the chief ornaments of Broadway, and among the most notable commercial buildings of the day. A beautiful type of stone construction). Stone-Aug. 2500 w.

We supply copies of these articles. See introductory.

*7609. A Short Description of the Rise and Decay of Gothic Architecture in England. F. J. Webber (Illustrated by cuts showing the evolution and decline described). Ill Car & Build–August 7. 2200 w.

*7612. Liverpool Museum Extension and Technical Schools (Perspective view, plans, and descriptive text of the selected design). Builder–Aug. 8. 1000 w.

*7613. Proposed Extension of the Edinburgh Municipal Buildings. R. Morham (Illustrated description and general remarks). Brit Arch–Aug 7. 1000 w.

*7616. The Brook Hospital, Shooter's Hill (Interesting illustrated general description). Arch, Lond–Aug. 7. 4500 w.

*7618. Church of Montivilliers (Interesting description, with inset, two-page line engraving). Arch, Lond–Aug. 7. 1500 w.

7629. A New Method of Fireproofing (Illustrated description of a new departure in fireproof construction used in the Barclay St. ferry house). Eng News–Aug. 13. 600 w.

7634. Recent Changes in Formulæ and Data Used in Determining the Strength of Materials. F. E. Kidder (The more recent formulæ and unit loads and strains at present most commonly used by structural engineers and architects). Arch & Build–Aug. 15. 1800 w.

7635. L'Enfant and the Planning of Washington. Charles Burr Todd (Historical note). Am Arch–Aug. 15. 800 w.

7781. The Harrison Building, Philadelphia (Illustrated description of constructive details. Part first contains general description, foundations, roof and beam plans, general sections and elevations). Eng Rec–Aug. 22. Serial. 1st part. 1700 w.

†7815. Style in Residential Architecture. C. E. Jenkins (The subject is discussed principally from the Chicago standpoint, the styles exemplified in that city being chiefly referred to). In Arch–Aug. 2000 w.

†7816. Chicago's Latest Steel Frame Building (Illustrated Description of the Trude Commercial Building). In Arch–Aug. 1500 w.

7830. A German System of Metal Stair Construction (The system illustrated and described is a Prussian invention). Eng News–Aug. 27. 400 w

7845. Church Architecture in America (Editorial review of a letter of Prof. Hamlin to the *Century*. Agrees with Prof. Hamlin that the majority of the modern churches of the United States lack dignity, repose, and ecclesiastic character). Arch & Build–Aug. 29. 800 w.

7847. Ancient Mural Decorative Art in Scotland. Thomas Bonnar (Read before the Edinburgh Archæological Association. The general character and the special characteristics of the art as exemplified in existing examples in Scotland). Arch & Build–Aug. 29. 4000 w.

*7855. Bonding of Brickwork (Illustrated description of a method of bonding with steel ties). Br Build–Aug. 600 w.

*7946. Principles Governing the Design of Foundations for Tall Buildings. Randell Hunt (The origin of these buildings, necessity of providing for settlement, the importance of knowing the exact character of the soil upon which the structure is to be built, comments on principles and discussions of different constructions). Jour Assn of Eng Soc–July. 9800 w.

8030. Specifications for Structural Iron and Steel. B. L. Worden, in the *Wisconsin Engineer* (A paper intended more especially for those whose experience is yet to be acquired, hoping it may lead to more complete study and better understanding of the subject). Arch & Build–Sept. 5. 1400 w.

8064. City Tower of Chicago (Brief illustrated description of a proposed structure). W Elec –Sept. 5. 600 w.

†8089. The New Cathedral of St. Thome, Mylapore, Madras (Interesting description). Ind Engng–Aug. 1. 2000 w.

Heating and Ventilation.

7668. An Extensive Single circuit Hot-Water System (Illustrated detailed description of plant for heating five buildings belonging to the Craig Colony for Epileptics at Sonyea, N. Y). Eng Rec–Aug. 15. 900 w.

*7677. The Principles of Gas Heating with an Example (Illustrated description of a new gas heater for apartments in buildings). Jour of Gas Lgt–Aug. 11. 2000 w.

7747. Steam Heating System in the United States Hotel, Paterson, N. J. (Illustrated description). Heat & Ven–Aug. 15. 400 w.

7898. Size of Registers and Flues for Indirect Heating. J. S. Bixby, Jr. (Chart from which the size of flues for indirect heating may be taken off without any computation, and description of method for using the chart). Met Work–Aug. 29. 350 w.

7918. Heating and Ventilating the First Baptist Temple, Brooklyn, N. Y. (Illustrated detailed description). Eng Rec–Aug. 29. 1800 w.

8017. Heating and Ventilation Apparatus of the Corcoran Gallery of Art, Washington, D. C. (Illustrated detailed description). Eng Rec–Sept. 5. 1600 w.

Plumbing and Gas Fitting.

7975. Return Circulation in Ordinary Plumbing Work. Charles Loraine (How to obtain a supply of hot water almost instantly when faucets are opened, whether they are or are not isolated from the reservoir. Illustrated by numerous diagrams). San Plumb–Sept. 1. 2000 w.

Landscape Gardening.

*7570. The Harmony of Architecture and Landscape Work. Ill. Downing Vaux (Stating the characteristics of landscape architecture in different nations, and the principles that guide the landscape architect in his work). Eng Mag–Sept. 2900 w.

7823. The Necessity of Planning. Charles Eliot (Utility and fitness must first be considered to most surely win expression, character and beauty). Gar & For–Aug. 26. 1200 w.

Miscellany.

*7577. The Ethics of the Sketch-Book. Paul Waterhouse (A word to students on the changed conditions which changes the purpose of the sketch-book, but does not destroy its usefulness). Jour of Roy Inst of Brit Archs–July 23. 2000 w.

*7578. The Training of Workers in the Applied Arts. Robert Anning Bell (Read before the Liverpool Soc. Causes that have retarded progress in architecture, sculpture and painting, and conditions to be desired in the relation of these arts). Jour Roy Inst of Brit Archs–July 23. 3000 w.

7592. The Nivet Apparatus for Testing Building Materials. From *La Nature* (Illustrated description of an apparatus for testing building materials (other than metals) that seems to be destined to render valuable services). Sci Am–Aug. 15. 2000 w.

*7602. The Mansfield, Indiana, Sandstone. T. C. Hopkins (Illustrated description of this building stone, the location, varieties, colors, etc). Stone–Aug. Serial. 1st part. 2800 w.

*7610. Architecture in the Capital of Tasmania (A general and entertaining description of the principal architectural features of Hobart, said to be the most English-looking city in Australia). Builder–Aug. 8. 3000 w.

*7611. New Infirmary, Halifax (A general description). Builder–Aug. 8. 1200 w.

7633. More Facts for Consideration (Editorial. Effect upon general trade, and particularly upon building enterprises, of the present agitation of the silver question). Arch & Build–Aug. 15. 1300 w.

*7679. Some Worcestershire Churches (Descriptions of special features, antiquities, etc., in the churches of Wyre, Throckmorton, Fladbury, Cropthorne and Wick in the diocese of Worcester, Eng). Arch, Lond–Aug. 14. 3000 w.

7720. Report of the Committee on Fireproofing Tests (This report was prepared by a committee of four gentlemen; one appointed by the Tariff Assn. of New York, one by the Architectural League of New York, and two by the Am. Soc. of Mech. Engs. An account of the tests and the results is given, with diagrams and engravings). Arch & Build–Aug. 22. 1500 w.

7748. Some Points About Chimneys. Charles Desmond (Construction of chimneys for securing maximum efficiency). Heat & Ven–Aug. 15. 2000 w.

†7813. The Proper Unit Stresses for Timber. F. E. Kidder (A plea for uniformity in a standard of unit stresses, comprising a review of building laws in various cities as related to strength of materials). In Arch–Aug. 1600 w.

†7814. Plastering Methods and Materials. Thomas Jones (Substance of a paper read before the Illinois Chapter of the American Inst. of Architects, at Chicago. A scientific dissertation on the ingredients of mortar for plastering, their mixture, tempering, application, etc). In Arch–Aug. 4200 w.

7846. The Legal Duties of Engineers and Architects (Address of Pres. Jas. C. Bradford before the Engng. Assn. of the South. The relation of the architect and his employer is similar to that between lawyer and client, or of physician and patient. The moral and legal responsibilities involved in the relation are the theme of the address). Arch & Build–Aug. 29. 2200 w.

7852. Characteristics and Properties of Wood (Valuable information for architects and engineers, prepared by B. E. Fernow, of the Div. of Forestry Dept. of the United States). Can Arch–Aug. 3500 w.

*7853. Andrea Della Robbia and His Altarpieces. Allan Marquand (General characteristics which distinguish the work of the later Robbia school, the most striking of which is the production of terra cotta altar pieces. Specimen of this work illustrated in half-tone). Br Build–Aug. 1500 w.

*7854. A New Fire-Proofing System (System devised by Mr. George Rushforth, architect, of Stockton, Cal. Illustrated). Br Build–Aug. 250 w.

*7856. Colors for Country Buildings. A. Ashmun Kelly (Considers the relation of the color of buildings to the environment, and also to the character of the architecture). Pl & Dec–Aug. 1. 1000 w.

*7994. The Lithology of Building Stones. T. C. Hopkins (Thirty-eight varieties of stone are examined and the writer aims to give the best intepretation of the terms as an aid to those who have not made a special study of the subject). Arch, Lond–Aug. 21. 4800 w.

*7995. Industrial Design in Art Schools. Lewis F. Day (The author's impression on the teaching as he saw it, saying where it seems to fail, and how he thinks it might be bettered). Arch, Lond–Aug. 21. 4000 w.

8004. A Modern Office Building (Illustrated description of the roofing and cornice, plumbing and gas fitting, steam and hot water fitting, kitchen equipment, etc., of the Gerken Building, New York). Met Work–Sept. 5. 7800 w.

*8005. The New Congressional Library. E. A. Hempstead (Historical and descriptive, with plan and illustrations). Chau–Sept. 4800 w.

*8007. Quaint Houses in the Bermudas. Mary F. Honeyman (Interesting description of the architecture of these islands, with general remarks). Chau–Sept. 2500 w.

*8060. Model "Model Tenements." William Howe Tolman (Presents some of the results attained by English and Scotch cities). Arena–Sept. 3000 w.

*8085. A Restoration of the Mausoleum at Halicarnassus. J. J. Stevenson (A study of this mausoleum, which was one of the most noted structures in the ancient world, and the remains of which are now in the British National Museum). Builder–Aug. 29. Serial. 1st part. 3800 w.

*8086. The Most Remarkable Sight in Paris (Refers merely to the outward aspect of buildings and their surroundings. The writer thinks it the great modern church of the Sacré Cœur Montmartre). Builder–Aug. 29. 1300 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

The Calculation of Flood Waves.

THE Gohna landslip and flood, which will be generally remembered as having afforded one of the most remarkable instances extant of engineering calculation successfully applied to an extraordinary phenomenon, is recalled by *Indian Engineering* with apparently hypercritical comment.

The circumstances are well known: in September, 1893, an enormous landslip from the mountain of Maithana, on the right bank of the Birahi Gunga, swept across the river, damming it up completely; in October another great fall came down upon the first, making a barrier 900 feet high, 3,000 feet long on the top, and 600 feet long at the bottom of the gorge, with a cross section measuring 2,000 feet through at the top and 11,000 feet through at the base.

Behind this great dam were the rising waters of the river, soon to be augmented by melting snows and periodical rains; below, the narrow valley (falling 250 feet to the mile at Gohna) stretched away 150 miles to Hardwar before debouching on the plains of northern India, and its course was dotted with shrines and traversed by streams of pilgrim devotees.

Protective measures against the inevitable flood were at once instituted by the government. Contoured maps of the valley were made, the area and volume of the lake which would be formed were accurately determined, the height of the flood-wave which would follow the bursting of the dam was calculated, danger lines marked, signal stations established, and property within the menaced area as far as possible removed or dismantled.

Most remarkable of all, the date when the rising waters would overtop the dam was fixed within ten days, the error being on the safe side: the flood actually occurred on August 25 (instead of August 15 as precalculated), and, thanks to the precautions taken, not a single life was lost.

The *Indian Engineer* thinks that a different management of affairs at the crest might have brought the final breach during the daytime, instead of at night; but a careful perusal of the authoritative account makes it apparent that every effort was made to this end, and the failure was due to causes beyond the engineer's control; but, further than this, the *Engineer* is distressed because the motion of a flood-wave of the character has not been reduced to rule, and the credit for the remarkable accuracy of the predictions in this case is to be ascribed wholly to the engineers in charge. "The highest level touched by the flood at every point along the line was guessed by Colonel Pulford in advance, with an approximate correctness most surprising, but all of us can scarcely always hope to have such happy intuition or such luck. Given the details of a channel, and varying volume of some short-time discharge entering into it, we ought to have some sound, if approximate, theory to show the maximum flood-level at each point down stream."

"The details of a channel and varying volume of a short-time discharge" involve such an infinity of variations and permutations that the "sound, but approximate, theory" could be nothing but a compilation of manifold independent solutions of as many different problems. It is, to say the least, extremely doubtful if any general formula (which seems to be the point *Indian Engineering* is striving for) can possibly be deduced or applied at all.

The form, contour, and configuration of the main valley and its tributaries, the material composing the banks, the volume and condition of the main stream before the flood wave is superimposed, the state of all tributary channels, and the rate of liberation of the flood are all factors which may vary the calculation between limits so wide that any suggestion of a "general theory" seems idle. The

solution must be found in intelligent study of each case, such as that which made the Gohna flood a memorable exemplar of the exactness of engineering science.

It is of interest to note that our own weather bureau has recently undertaken a similar, if somewhat less brilliant, service with relation to the winter floods on western rivers. Their predictions as to expected stages are still of too recent inauguration to win absolute confidence, but may be made a feature of incalculable value. The experienced river-man who hangs about the bulletin boards in our western river cities and confidently predicts "how many more feet she's a-comin" is picturesque, but very unreliable.

His basis of calculation is usually wholly empirical, having for its foundation usually some particularly remembered difference between up and down river points observed during a former flood, and confidently expecting a repetition of the same difference at every succeeding one, with calm indifference to widely varying conditions in the intervening tributaries or the local rainfall. The ancient prophet is always absolutely confident that a freeze "checks the flood," never having discovered that the flood-making waters are in the rapidly-flowing stream a few hours after the rain falls on the water-shed, and are thenceforth unaffected by even severe cold.

The fact that the first days of a thaw do not affect the river, if observed, remains an unexplained mystery, when a tramp across any snow-field would serve to show that the snow acts as a sponge, holding back, in its lower layers, the water first melted, and suddenly liberating all, when the last few inches are thawed.

Such extraordinary disasters as the Gohna flood are rare, but the western flood we have always with us, and exact and reliable precalculations would be of inestimable advantage to the business enterprises necessarily located with the flood limits; even if a "sound, but approximate, theory" is hardly to be expected, the engineer can find here a field for useful and profitable calculation.

The Age of Projected Ship Canals.

THIS appears to be the age of the discussion of ship-canals, if the term "discussion" be properly applied to the advancement of more or less practicable schemes by some enthusiastic advocate, and their prompt retirement into oblivion, for a period at least.

The remarkable feature of the movement is the slender basis of practical, successful enterprise by which so much projected construction is suggested. The Suez canal, of course, remains as the shining example of a substantial revolution in commercial routes effected by canal construction, although it has by no means caused an entire abandonment of the route to the east around the Cape of Good Hope; but this particular enterprise was favored at once by the possibility of securing an enormous saving in distance, and the absence of serious engineering difficulties in its construction.

If the conditions had been equally favorable as to the second point on the Isthmus of Panama, no doubt one, and possibly two, artificial waterways would have long since intersected it, furnishing new stimulus to commerce and incidentally to the ship-canal idea; but here the engineering difficulties have so far prevented an economical solution, and it is still incumbent upon the projectors to show cause why nature's temporary injunction should not be made permanent.

In the cases of other recently-completed undertakings, the saving of time, distance, or cargo-handling does not seem to have proved as tempting to navigators as precalculated, and new waterways, from which much was expected, languish in comparative idleness.

Such is the Baltic and North Sea canal, to which the officials, according to recent report, are hoping to attract a much needed increase of tonnage by readjustment of the tolls; and from all accounts the Manchester ship canal has proved somewhat similarly disappointing.

But the schemer is still undaunted. The project of a canal from the Bay of Biscay to the Mediterranean has recently come up again for its periodical killing.

In fact, ship canals are "in the air"; an excited astronomer sees them on the planet Mars, and, possibly because the Martian "canals" are seen double, one engineer is exploiting a scheme for paralleling the Suez canal by a new route, starting from the Bay of Aboukir, cutting into the Nile, following the stream for some distance, and thence striking eastward into the gulf.

In our own country there is urged the importance of an outlet from the great lakes to the Mississippi, at the western end, and one to the Hudson, at the eastern; more recently still, we have had the clamor of the competing advocates of two, or maybe three, routes from Lake Erie to the Ohio, although, as one unkind critic says, it seems of doubtful expediency to carry a sixteen-foot canal into a five-foot river.

As a matter of fact, marine commerce, as conducted at present, is not eager to secure a small net saving at any great risk or difficulty of navigation. The successful ship canal must either offer a material reduction of time in transit, or, if this saving be small, it must give easy navigation and very moderate tolls, which means that it can be successfully constructed only in situations where the conditions permit of good engineering work at reasonable cost.

No doubt the canal system of this country can be largely developed to most excellent advantage. The possible political benefits of an independent outlet for our lake commerce through our own territory to the sea are plainly manifest.

Many of the other projects may ultimately be carried to a successful and profitable conclusion; but the conditions at Suez are not often repeated, and the economic conditions of the times are hardly suited to any brilliant, but possibly uncertain, effort to eclipse it.

The Health of Caisson Workers.

A NOTABLE development in recent engineering construction is the larger application found for compressed air. The sudden and rapid growth of the tall building especially—by many persons regarded as the most striking departure in modern engineering—has made almost an everyday application of a method once held in awe by the laity, and regarded, even by the profession, as an unusual incident of underground work, appropriate chiefly to bridge and tunnel construction.

With so extended use and increase in the number of men employed, there has naturally arisen a heightened interest in the hygienic relations of the system, and a concentration of study upon the elimination, or at least the reduction, of the risk which attended the early undertakings of this character.

Improvement in mechanical appliances happily has lessened the number and seriousness of sudden disasters; the study of able and painstaking investigators, in both the engineering and the medical profession, seems likely to result in an equal betterment of sanitary conditions. In the August number of THE ENGINEERING MAGAZINE we reviewed the very practical success of Mr. E. W. Moir, one of the most successful submarine-tunnel engineers, and especially his device of the "air-lock" for treating, by a gradual reduction of pressure, workmen who had been overcome by the effects of a compressed atmosphere. A recent number of the *Sanitarian* gives an abstract of a consular report embodying the conclusions which an Austrian authority, Dr. Neudorfer, derives from an independent study of the same subject.

Dr. Neudorfer's conclusions, confirmatory of the opinions of Rameaux and Paul Bert, are thus summed up.

"There are two things that the workers in caissons have to guard against:

"(1) The concentrated oxygen, which, at a pressure of five atmospheres, affects the nervous system injuriously, causing cramps, tetanus, diminishing oxidation, and the formation of carbonic acid gas. It has been proven by experiments on men and animals that, when there is an increase of twenty per cent. in the amount of oxygen, the process of oxidation in the body is less rapid, less carbonic acid gas is formed, and the heat of the body is diminished. This first danger is the least serious, as the pneumatic pump causes a gradual compression of oxygen, to which

the system generally adapts itself; and in any case there are premonitory symptoms which make it possible to remove the workmen before the case becomes dangerous. Little inconvenience is caused, until the pressure exceeds four atmospheres.

"(2) The concentration of nitrogen, which affects the blood instead of the nervous system. With the increase of pressure, the nitrogen becomes more and more concentrated, and the absorption of this gas by the blood increases proportionately; when a decrease in the atmospheric pressure causes the absorption of a smaller quantity of nitrogen, the gas escapes in fine bubbles, which circulate through the veins and prevent the blood, by their expansion, from circulating in the capillary veins. This checks the flow of arterial blood, and affects the spinal column and the brain. In experimenting with animals, death is caused instantaneously when a high pressure is suddenly reduced. The best method for obviating this danger is to reduce the pressure slowly, so that the blood can get rid of the free nitrogen gradually. At the entrance to the caisson there should be a separate compartment filled with compressed air. When the workman desires to leave his work, he should shut himself in this compartment, and gradually reduce the pressure by letting the compressed air escape.

"According to the opinion of Dr. Neudorfer, of Vienna, an hour and a quarter should be spent in reducing the pressure of 3½ atmospheres, in order that the risk may be as small as possible. The decrease of pressure is regulated according to the regulator of Denayrouze.

"In cases where, in spite of all precautions, a workman is affected, inhalations of pure oxygen are found to be the most simple and effective remedy."

The similarity of Dr. Neudorfer's remedial treatment to that proposed by Mr. Moir is striking. There is a partial accord between the opinions of the two authorities as to the causes which produce the disordered circulation; but, while Mr. Moir was inclined to consider carbonic acid the chief disturbing agent, Dr. Neudorfer evidently finds it unnecessary to look beyond the ordinary constituents of a normal atmosphere,—oxygen and nitrogen.

Engineering as a Closed Profession.

"HER Majesty, by and with the advice and consent of the legislative assembly of the province of Manitoba," has enacted a bill "which may be cited as the Manitoba Civil Engineers' Act," by which the profession is closed in the province of Manitoba.

This is in line with the tendencies which have recently been so strongly marked, both in public and private expression, throughout the dominion, and the passage of the act seems to have been directly secured by the influence of the Canadian Society of Civil Engineers, working through their committee. It will be generally regarded, in the country, as a step backward; but an examination of the text of the bill shows the step to be almost amazingly short and hesitating. Sixteen of the eighteen sections are devoted entirely to the organization, constitution, and administration of The Canadian Society of Civil Engineers; the remaining two sections are as follows:

17. On and after the 1st day of July, 1896, no person shall be entitled within this province to take or use the name and title of "civil engineer" or any abbreviation thereof, either alone or in combination with any other word or words, or any name, title, or description implying that he is a member of the said Society of Civil Engineers, or act as engineer in laying out, advising on, constructing, or superintending the construction of any railway or public work, or any work upon which public money is expended, the cost of which shall exceed $500, unless such person is a member of the Society hereby incorporated and registered as such under the provisions of this act, or unless he is a duly qualified civil engineer, and entitled to use the title of civil engineer by virtue of some statute in force in this province, or by the authority of some institution of learning in this province having authority to confer degrees in civil engineering, or unless he has been practising as a civil engineer in this province at the time of the passing of this act, or unless he is a member in good standing of some institution of civil engineers in

Great Britain and Ireland, or of some national society of civil engineers of good standing in any foreign country.

18. This act shall be deemed a public act.

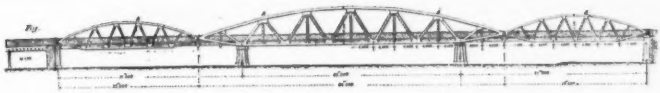
As remarked by the *Engineering News*, from whose columns we quote the reprint of the bill, "the breadth of the exceptions is praiseworthy; but it is also to be noted that the law provides no pains or penalties for those who disregard its provisions."

It is rather severe on the registrar of the society who shall "make or cause to be made any falsification in any matter relating to the register," but a violation of the act itself is not even declared to be a misdemeanor.

To commend an act for its omissions and exceptions is decidedly to damn it with faint praise, but it is the only ground upon which commendation could be extended to a measure which, in principle, has no justification in public policy, and can scarcely fail to result in formalism and stagnation within the profession.

An Interesting Bridge Design.

A BRIDGE recently completed in Paris, and designed to carry a new street—the Rue Tolbiac—across the station-yard of the Orleans railway, is briefly noted by *Engineering*, with the promise to return to the subject when further illustrations are published.



THE RUE TOLBIAC BRIDGE.

It is said to present "some interesting constructive features," one of which is the peculiar form of the central span, which extends over the piers, as shown by the accompanying illustration, carrying on its projecting ends the ends of the girders of the two outer spans.

The key to the unusual construction will, no doubt, be found in the peculiar conditions attending the erection of the bridge, which are described as "exceptionally difficult, not only on account of the binding gradients, but also because the bridge had to be erected without interfering with the constant and heavy traffic of the station yard." In all probability the conditions of this traffic and the unalterable location of track so predetermined the placing of piers as to render this somewhat novel solution of the problem most expedient and economical.

The total length of the bridge is 525 feet between abutments, and it is divided into three spans, the center one of which rests on two piers: the distance between the piers is 196 feet 10 inches, and the length of the central girder is 275 feet 7 inches; the width of the bridge is 55 feet 9 inches. The work is the design of M. Salles, Ingénieur des Ponts et Chaussées, and it was erected under the direction of MM. Huet and de Tavergnier.

European Inland Waterways.

IN connection with the discussion of canals, great and small, it is of considerable interest to observe the attitude of the English press and public toward their canal system, which, though apparently unsatisfactory to them, is certainly developed to a much higher extent than we have as yet contemplated in this country. A British contemporary says: "It does appear strange that so little attention is paid to our canals, not only by the Board of Trade but by the public generally. Possibly the supreme financial importance of the Manchester Ship Canal causes one to overlook the fact that there is still such a system in actual operation, and that it conveys annually a considerable quantity of merchandise, as our recent articles on English canals have shown. The official, *i. e.*, Government, returns of these waterways is of by no means recent date, nothing having been issued on the subject since 1890, and the Blue Book of that year dealt only with figures up to 1888. Private research, however, shows that railway competition has by no means exercised such disastrous effect upon traffic

by canal as by stage coach and wagon. The following particulars dealing with the year 1893-4 may prove interesting:

	Miles.	Traffic. Tons.	Revenue. £
England and Wales	3050	34,325,179	1,876,423
Ireland	600	519,580	95,864
Scotland	154	1,456,361	69,189

Of these the canals owned and worked by railway companies were as follows:—

	Miles.	Traffic. Tons.	Revenue. £
England and Wales	1024	6,60?,304	437,080
Ireland	96	30.368	6,495
Scotland	84	1,386,617	57,178

The capital expenditure was estimated to amount to £32,749,793. Another interesting fact about our comparatively neglected and despised waterways is that they show to better advantage than do those of our continental neighbors. In 1895 a Foreign-office return was issued, which showed that Germany possessed only 1349 miles of canals and canalized rivers, which had cost for construction, maintenance, etc., between 1880 and 1893, £11,677,750, and France had 3003 miles of canals, on which had been expended by the government £20,638,861. But, however well we bear comparison with these two up-to-date continental neighbors, it appears a pity that more use cannot be made of our inland waterways. Sir John Brunner is of the opinion that they could be so improved as to be of more benefit to trade than the proposed light railways, and undoubtedly there is much in what he says.

There are miles upon miles of canals in the kingdom which are practically idle. Certainly in some cases an attempt is being made to improve matters. In connection with the Worcester Canal, for example, which may in time render it possible for small coasting steamers to reach Birmingham, and this is perhaps as large a class of steamers as it is desirable to cater for. However much a ship canal capable of accommodating larger vessels may gratify the vanity of our inland towns, there are few of them which could support such an enterprise. It would be enough for them to be able to accommodate steamers of up to 400 to 500 tons cargo, with goods to be transhipped to waiting liners at our great ports. In connection with the majority of our at present little used canals, even this would be unnecessary. A service of steam launches to tow canal barges would be quite enough, and were this applied to canals at present either not utilized at all, or used only to a small extent for traffic in connection with the transport of goods where time is of minor importance, a great benefit would be conferred upon community and canal owners."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

7632. The Design and Specifications for the Fairmount Park Bridge. John Sterling Deans (Letters setting forth the facts relating to this structure. A protest was presented to the commissioners of Fairmount Park against the award of the contract). Eng News-Aug. 13. 5200 w.

7662. Bridge Over Minnesota River—Minneapolis and St. Louis Railroad (General view and principal details of a three span Pratt combination bridge). Ry Rev-Aug. 15. 400 w.

7723. The New Albert Bridge, Near Brisbane, Australia (Descriptive account with illustrations). Ry Rev-Aug. 22. 1800 w.

*7741. Suspension Bridges (Comments on the probable revival of the suspension bridge with a stiffening truss, and discusses the bending moments in a two-hinged and three-hinged girder). Engng-Aug. 14. Serial. 1st part. 1600 w.

7824. The Cernavoda Bridge Over the Danube River (Illustrated description of cantilever bridge). Eng News-Aug. 27. 800 w.

7872.—$1. The Reconstruction of Grand River Bridge. W. A. Rogers (Illustrated description with statement of cost for the different kinds of work). Trans Am Soc of Civ Engs-Aug. 5500 w.

*7948. Riveted Joints. Joseph R. Worcester (The subject of increase of strength of riveted joints under ordinary working strains, due to the friction of the contact surfaces of the plates or shapes riveted together, and the question of how much of the strength of the joint is due to this friction. Data and conclusions, tests and experiments, with discussion). Jour of Assn of Engng Soc-July. 9500 w.

*8072. The Tolbiac Bridge in Paris (Illustrated description of a bridge which has recently been constructed under special conditions, and

presents many novel and interesting features in its design). Engng-Aug. 28. 2700 w.

8109. The New East River Bridge (States the changed conditions which make a bridge connecting New York and Brooklyn farther north a necessity, its location and a brief illustrated description). Sci Am-Sept. 12. 1700 w.

Canals, Rivers and Harbors.

7631. A Proposed New Location for a Nicaragua Ship Canal. J. T. Ford (A skeleton sketch with a proposed survey which the writer thinks would economize). Eng News-Aug. 13. 1000 w.

7649. Caisson, North Pier Head, Madras Harbor. Robert W. Thompson (A paper read before the Inst. of Civ. Engs. Describes caisson building and sinking, and construction in the dry of monolithic pier heads of concrete). Ry Rev-Aug. 8. 2500 w.

7706. Effect of Engineering Works on Water Currents (Effect of combined wind and water action with maps of typical river outlets and an illustration of an unwise attempt at river regulation. Abstract of paper read by Mr. Cyrus Carroll, before the Canadian Society of Civil Engineers). Eng News-Aug. 20. 600 w.

7842. The Chicago Drainage Canal (Historical and descriptive account, with some figures). R R Gaz-Aug. 28. 2000 w.

*8006. Joining the Atlantic to the Pacific. George Ethelbert Walsh (A review of interesting facts connected with the three great canal routes whose construction has engaged the attention of the commercial world). Chau-Sept. 4500 w.

8016. Hydraulics of Rivers Having Alluvial Beds. Abstract of paper by George Y. Wisner (A study of the movement of water and sedimentary material in rivers). Eng Rec-Sept. 5. 2000 w.

*8100. Docking the River at Swansea (A scheme under consideration, with plan. The advantages and objections). Eng, Lond-Aug. 28. 1000 w.

Hydraulics.

7581. Hydraulic Apparatus. William Perry (Causes that enable the syphon to perform its work, and the origin of the name "ram" and why applied to the invention bearing its name). Can Eng-Aug. 1200 w.

7626. Locks and Dams on the Great Kanawha River, W. Va.) Information, with illustrations, of work done on this river, showing that the government money has been wisely expended in this case and the results satisfactory). Eng News-Aug. 13. 1800 w.

7705. The Foundations of the Herr Island Lock and Dam, near Pittsburg, Pa. (Illustrated description). Eng News-Aug. 20. 900 w.

*7949. A Low Crib Dam Across Rock River. J. W. Woermann (Illustrated description of one of the structures of the Illinois and Mississippi Canal, built for the purpose of furnishing slack water navigation in Rock River above the Lower Rapids. The crib-work, or dam proper, only are considered in this paper). Jour Assn of Engng Soc-July. 3800 w.

8034. Vertical Lift Lock for Dortmund and Ems Canal, Heinrichenburg, Germany (An illustrated description of a lock possessing several novel features in its construction. It corresponds in size to the proposed lift lock in the Erie Canal at Lockport, N. Y., and is interesting to study the ideas of foreigners in the solution of their similar problem). Eng News-Sept. 3. 1000 w.

8039. Water Development on the Mojave River, near Dagget, Cal. J. B. Lippincott (Illustrated description). Eng News-Sept. 3. 1800 w.

Miscellany.

†7573. Data Pertaining to Rainfall and Stream Flow. Thomas T. Johnston (An account of methods and a general discussion accompanies the extensive tables of results of systematic observations presented in this valuable contribution to engineering data (Jour of West Soc of Engs-June. 4800 w.

†7574. Notes about the Geology and Hydrology of the Great Lakes. P. Vedel (A summary of what is known of the nature and origin of the great American lakes, with geological and hydrographical maps and charts). Jour of West Soc Engs-June. 11000 w.

7699. The Richer Tachymeter. F. D. Lyphart (The history, description and theory of an important instrument). Eng News-Aug. 20. 900 w.

7701. Who Should Prepare Specifications? (An editorial upon the proper attitude of the profession toward this question). Eng News-Aug. 20. 1300 w.

7702. Fishway for Dam at Sterling, Ill. (Illustrated description). Eng News-Aug. 20. 100 w.

7703. Civil Engineering a Close Profession in Manitoba (Text, and general remarks, of an act regulating the professional practice of civil engineering in Manitoba, approved March 19, 1896). Eng. News-Aug. 20. 1800 w.

7803. The Road of the Future.—Solution of the Bad Thoroughfare Question (Advocacy of steel-rail roadways, by Gen. Stone of the Agricultural Dept). Clay Rec-Aug. 12. 1300 w.

7831. Impermeable Covering for Stone Arches (The covering herein described and discussed, with directions for preparation and application, is a mastic asphalt, used to prevent infiltration of rain water). Eng News-Aug. 27. 1000 w.

7870.—$1. The Suspension of Solids in Flowing Water. Elon Huntington Hooker (An important and laborious dissertation with formulæ and tabulated data). Trans Am Soc of Civ Engs-Aug. 30000 w.

*7940. Allowable Magnesia in Portland Cement. Irving A. Bachman (A review of investigations and discussions of the question of magnesia in Portland cement since 1891, looking to the maximum percentage permissible without endangering the quality of the cement). Munic Engng-Sept. 2000 w.

*8099. The Port Talbot Railway and Dock (Descriptive account of an extensive project for developing a Welsh coal district, and coal-shipping port). Eng. Lond-Aug. 28. 3300 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Architecture.

The Latimer Clark Cell.

THIS standard cell, legalized by the British board of trade, is of such value and importance in electrical engineering that it has been made a part of the syllabus of a number of engineering schools. The legal E. M. F. of the cell at fifteen degrees C. is 1.434 volts. Mr. J. Warren, in *Electricity* gives elaborate instructions for the preparation of this standard cell, from which—passing over some general remarks—we condense what follows, which may be of use to any amateur who wishes to make up one of these standards. The materials are as follows:

Pure mercury; neutral solution of zinc sulphate; a rod of pure redistilled zinc; mercurous sulphate; zinc oxid; platinum wire of about No. 22 B. W. G.; a wide-mouthed test-tube; and a cork to fit the mouth of the test-tube.

The mercury must have been recently purified by washing with acids and redistillation in a vacuum. The mercurous sulphate, sold as pure, must be twice or thrice, successively, washed with pure cold distilled water, in a flask, and shaken thoroughly, and the water must be drained off as much as possible after the final washing.

The mercury forms the negative pole in the bottom of the cell, through and into which the platinum wire may be fused, leaving a free end on the inside coiled into a spiral for contact with the mercury, and a free end outside for a terminal connection.

Mr. Warren prefers to pass the platinum wire down into the mercury through a sealed glass tube inserted through the cork finally used to seal up the cell, and extend this tube down into the mercury below its upper surface; this will be found the most convenient way for amateurs in making up these cells. The wire should be passed through and sealed into the ends of this protecting tube by fusing the glass upon the wire with a blow-pipe.

The cell, when made up, consists of the mercury in the bottom of the tube with its platinum contact, a supervening electrolyte of a paste made by mixing mercurous sulphate with saturated solution of zinc sulphate, and the positive zinc rod, to the upper end of which a copper terminal is soldered. But, in making up this cell, as in many other things, the practical details are of great importance, and it is only by careful attention to these that the standard E. M. F., without which the cell is worthless, can be obtained.

Make a saturated solution of pure recrystallized sulphate of zinc, by mixing in a flask distilled water with nearly twice its weight of the crystals of pure zinc sulphate, adding oxid of zinc in the proportion of about two per cent. by weight of the zinc sulphate crystals, to neutralize any free acid. The crystals should be dissolved with the aid of gentle heat, but on no account should the temperature to which the solution is raised exceed 30° C.

Mercurous sulphate, treated as described hereafter, is then added in the proportion of about twelve per cent. by weight of the zinc sulphate crystals, and the solution filtered, while still warm, into a stock bottle. Crystals should form as the liquid cools.

At temperatures above 30° C. the zinc sulphate may crystallize out in another form; to avoid this, 30°C. should be the maximum temperature limit. At this temperature water will dissolve about 1.9 times its own weight of the crystals. If any of the latter remain undissolved, they will be removed by the filtration.

The amount of zinc oxid required depends on the acidity of the solution, but two per cent. will be ample in all cases which arise in practice, with reasonably good sulphate of zinc. Another rule for the addition of the oxid would be to add gradually until the solution becomes slightly milky.

The solution, when put into the cell, must not contain any free zinc oxid; if it does, then, when mixed with the mercurous sulphate, zinc sulphate and mercurous oxid are formed, and the latter may be deposited on the zinc, thus affecting the electromotive force of the cell. This difficulty is avoided by adding, as above described, about twelve per cent. of mercurous sulphate before filtration. This is more than sufficient to combine with the whole of the zinc oxid originally added, if it all remains free; the mercurous oxid formed, together with any undissolved mercurous sulphate, is removed by the filtration.

Mix the washed mercurous sulphate with the zinc sulphate solution, adding sufficient crystals of sulphate of zinc from the stock bottle to ensure saturation, and a small quantity of pure mercury. Shake these up well, together, to form a paste of the consistency of cream. Heat the paste, but not above a temperature of 30°C. Keep it for an hour at this temperature, agitating it from time to time, and then allow it to cool; continue to shake it occasionally while it is cooling. Crystals of sulphate of zinc should then be distinctly visible, and should be distributed throughout the mass. If this be not the case, add more crystals from the stock bottle, and repeat the whole process. This method ensures the formation of a saturated solution of zinc and mercury sulphates in water.

The treatment of the mercurous sulphate has for its object the removal of any mercuric sulphate, which is often present as an impurity. Mercuric sulphate decomposes in the presence of water into an acid or a basic sulphate. The latter is a yellow substance (turpeth mineral) practically insoluble in water; its presence, at any rate in moderate quantities, has no effect on the cell. If, however, it be formed, the acid sulphate is formed also. This latter is soluble in water, and the acid produced affects the E. M. F. of the cell. The object of the washings is to dissolve and remove this acid sulphate, and for this purpose the washings previously described will, in nearly all cases, suffice. If, however, a great deal of the turpeth mineral is formed, it shows that there is a great deal of the acid sulphate present, and it will then be wiser to obtain a fresh sample of mercurous sulphate rather than try by repeated washings to get rid of all the acid. The free mercury assists in the process of removing the acid, for the acid mercuric sulphate attacks it, forming mercurous sulphate and acid, which is washed away.

Having thus prepared the various materials, the cell is made up as follows: At the bottom of a small test tube of about 2 c.m. diameter and 6 or 7 c.m. deep place the mercury, filling to a depth of about 1.5 c.m. Cut a cork about 5 c.m. thick to fit the mouth of the tube; at one side of the cork bore a hole, through which the zinc rod can pass lightly, and at the other side bore another hole for the reception of the glass tube containing the platinum wire; at the edge of the cork, cut a nick, through which the air can escape when the cork is pushed into the tube. Wash the cork thoroughly in warm water, and leave it to soak for some hours before use. Pass the zinc rod about 1 c.m. through the cork, clean the glass tube and platinum wire carefully, then heat the exposed end of the latter red-hot, and insert it in the mercury in the test-tube, taking care that the whole of the exposed platinum is covered.

Shake up the paste, and introduce it without contact with the upper part of the walls of the test-tube, filling the latter above the mercury to a depth of rather more than 2 c.m. Then insert the cork and zinc rod, passing the glass tube through the hole prepared for it. Push the cork gently down until its lower surface is nearly in contact with the liquid. The air will thus be nearly all expelled, and the cell should be left in this condition for at least twenty-four hours before sealing,—an operation which should be performed as

follows: Melt some marine glue until it is fluid enough to pour by its own weight, and pour it into the test-tube above the cork, using sufficient to cover completely the zinc and soldering. The glass tube, however, should project above the top of the marine glue.

The cell may be sealed in a more permanent manner by coating the marine glue, when set, with a solution of sodium silicate, and leaving it to harden.

The cell, thus completed, is standardized by comparison, and may then be mounted in any desirable manner. It will be found convenient to arrange the mounting so that the cell may be immersed in a water-bath up to the level of, say, the upper surface of the cork. Its temperature can then be determined more accurately than when the cell is in the air.

Electrical and Mechanical Engineering.

IN our "Review of the Industrial Press" we are often embarrassed to decide what department of the review would most appropriately receive the indexed title of some article. The boundaries — never sharply defined—between the specialities of engineering become more and more indistinct as time advances. It thus becomes difficult in many cases to decide whether a title should go under "Marine Engineering," or "Mechanical Engineering," or "Civil Engineering," or "Architecture," or "Electricity," etc. Of late, the puzzle with reference to electricity and other divisions of engineering has increased. Electricity is entering as a factor into every industrial activity, and a dissertation upon some one of its applications may seem to treat it more from the mechanical side than from the electrical side, and *vice versa*. Comparatively few articles relating more or less to both electrical principles and their industrial applications deal exclusively with either electrical or mechanical aspects.

The intimate connection between what can be considered unequivocally mechanical engineering, and what is purely electrical, in mechanical devices wherein electricity is applied, or in scientific electrical appliances which involve skilled mechanical construction, is creating a wide border-land which, by its very nature, must be held in common.

These remarks were suggested by an editorial in *Journal of Gas Lighting* (Aug. 1), in which the overlapping of electrical and mechanical engineering is traced from the early days of the telegraph down to the present date. When electric telegraphy had its beginnings, the "electrician" predominated, and "the title was recognized as representing a distinguished profession embracing the highest attainments in electrical practice and theory. An electrician in those days was looked up to with a feeling akin to awe and superstition by his contemporaries in other branches of mechanical work and by the general public. The marvels of the quadruplex and the ability to locate, by means of the Wheatstone bridge and the galvanometer, the exact position of a break or leak in a cable buried in mid-ocean seemed not the least of the astonishing features of the electrician's art, and very justly so."

Twenty years have brought about a marvellous change. In the field, the mine, the work-shop, the exchange, the mercantile establishment, the street, the ship that carries us across the sea, the vehicle that whirls about in towns and between towns and suburbs, the hospital, the hotel, the prison, and the domestic home, electricity is doing useful work, with mechanical design and construction of the highest order as its industrial handmaids. The mechanic of to-day frequently knows enough of electricity to have set up in trade an electrician of the forties. The electrician of to-day is often a better mechanical designer and constructor than could have been found without difficult search in the fifties. "The practical electrician of former times, who was fully qualified in the application of Ohm's law to the measurement of resistances and to the electrical testing of batteries and circuits, seemed to be, in the majority of cases, quite incapable of developing the mechanical constructive ability needed in the newer and heavier work which the generation and commercial application of these more powerful electric currents have called into existence." All this has changed. "There is, of

course, and always will be, an enormously large field for the profitable exercise of a thorough mechanical training. But, in view of the growing use of the dynamo and electric motor in manufacturing establishments and in modern machine-shop practice, in which they are now either supplanting or supplementing the steam boiler and engine (to say nothing of the increasing use of electricity in other technical and industrial processes), the up-to-date mechanical engineer must familiarize himself, if not with the fundamental principles of electrical science and the elements of electrical and electro-magnetic calculations and measurements, at least with the mechanical design, construction, operation, and control of the dynamo and motor and its general applications, in so far as the same may be useful to him in determining to what extent and in what connection the employment of electrical energy as a motive or controlling force may best be used in his construction work and other problems arising in his daily practice. Electrical applications, in fact, are so rapidly assuming an important place in nearly every department of engineering that an elementary knowledge of the science and its various uses in connection with his special department is to-day an essential requirement of every engineer, and particularly of the mechanical engineer."

But there remains a field for the purely scientific electrician. No one will assert that we have more than just entered upon the wide field of investigation presented by electrical phenomena, and this field will, for a long time, attract into the ranks of its explorers the foremost minds of successive generations.

Electric Railway Connecting New York and Philadelphia.

THE extension of electric propulsion to railroad lines of considerable length is to have its commercial practicability tested. The announcement that a syndicate of New York and Philadelphia capitalists will undertake to construct and operate an electric railroad between the cities named, which are nearly one hundred miles apart, has been made, coupled with the statement that the work will soon be commenced. .

From the engineering standpoint, there appears no reason why such a road could not be operated between New York and San Francisco. The success or failure of such an enterprise must always depend upon the receipts and expenditures. If these can be so related to each other over a distance of one hundred miles that a greater margin of profit can be retained for the investors than by other modes of propulsion, the question of electric motive power on trunk lines may be regarded as settled.

Of course, local conditions affect the question of feasibility; and through thickly-settled regions such conditions generally are favorable to electricity. Near New York and also near Philadelphia thickly-populated suburbs will contribute to the receipts of an electric road, without a proportionate increase of expenditures. The importance of this consideration as affecting the possibilities of the new road will appear from the following quotation (*The Electrical Engineer*, Aug. 19).

"The direct line of the main stem will begin at Paterson, where connection will be made with the present system. Then the road will pass through Upper Montclair, Montclair, Bloomfield, Orange, East, West, and South Orange, Maplewood, Wyoming, Springfield, Westfield, Fanwood, and Northwood, to a connection with the present system in Plainfield, and thence through Plainfield to Bound Brook. Crossing the New Jersey Central Railway at Finderne, the road will continue through Hillsboro and Weston, and thence to Millston, Rocky Hill, Princeton, Lawrenceville, and Trenton. Branches will run from Bound Brook to New Brunswick, Somerville, and Raritan; from Bloomfield to Irvington, and to Morristown, *via* Chatham and Madison. At Irvington connections will be made with the existing lines, making a direct route to Newark and Jersey City. From Westfield the road will run to Rahway, connecting there with the line to Lebanon and Boynton, South Beach, Woodbridge, and Perth Amboy. From Rahway the line will go to

Elizabeth, and a branch will connect Bound Brook with New Brunswick. From Trenton, the road will pass through Morrisville, Bristol, Cornwells, Terresdale, Tacony, Holmesburg, and Frankfort, and thence into Philadelphia."

The commercial and social relations between these towns (some of them large and all prosperous) and the terminal cities is so close that they may almost all be regarded as suburban with reference to New York or Philadelphia. From all of them numbers of business men go to the terminal cities each morning and return at night, and most of them have large manufacturing industries with head-quarters at one or the other terminals. The bulk of their family shopping is also divided between the larger cities, and the daily traffic between New York and Philadelphia is very great. The conditions are, therefore, very favorable to success.

A German Air-Pump.

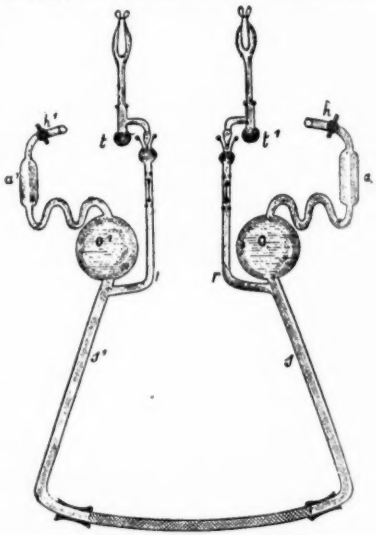
THIS form of double-acting mercury air-pump was designed by W. Bähr and E. A. Krüger, of Berlin. It appears to be an improvement upon preëxisting forms, and it is public property, not being patented. It operates twice as fast as the ordinary mercury pumps. *The Electrical Engineer* (Aug. 26) has an engraving and a description of the invention, extracted from a German source. From it we make the following abstract:

Two Tüpler pumps whose riser tubes, *s s'*, are only 40 cms. long, are connected by a rubber tube at their lower ends. The pump is mounted on a board so that the bulbs, *o' o*, are in the position shown.

The usual barometric tube is dispensed with, and immediately above the air accumulators, *a' a*, there is placed a glass cock; no other change is made in the pump. The board on which the pump is mounted is arranged so that it can turn upon a central horizontal axis, the motion on each side being limited by stops.

The pump is supplied with mercury, until the bulbs, *o o'*, are filled about one-half; the two cocks, *h h'*, are connected to a preliminary pump. The vessel to be exhausted is connected to the drying bulbs, *t t'*, and the preliminary pump set in action; by opening the cocks, *h h'*, the greater quantity of air is removed. Since the air is removed from both sides, the level of the mercury remains constant.

If now the board be turned on its axis, a difference in level ensues, the mercury in the bulb, *o*, falls below the tube, *r'*, connected with the vessel to be exhausted, while on the other side it forces the air through the accumulator, *a'*, where it is



DOUBLE ACTING MERCURY AIR-PUMP.

removed by the preliminary pump. On turning the board in the opposite direction, the same action is repeated, the mercury now falling in *o'*, and rising in *o*. The air is prevented from rushing back by the action of the bent capillary tubes, which retain the mercury. The oscillation of the board is continued until the mercury in the bulb touches the mercury thread in the M-shaped capillary tube,—that is, until it shows no air-space between them. With this combination one pump alternately serves as the mercury reservoir for the other, and its movement is fully utilized. With ordinary pumps the falling of the mercury must always be awaited before a fresh exhaustion can take place. The oscillation is a slow one, and hence breakage is almost completely prevented.

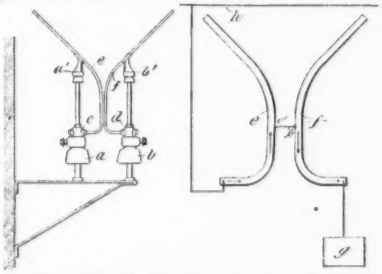
A German Lightning Arrester.

THE ELECTRICAL ENGINEER, from which we have reproduced on a smaller scale the accompanying engraving and have condensed the description of this lightning-arrester, says the efficiency and certainty of its action for currents of high voltage have been practically demonstrated. It is not likely to get out of order, as none of its parts are movable, and its construction is very simple. Placed out of doors, under a hood, it does its work without further attention.

The instrument, ready for use, is shown at the left of the engraving. At the right hand is a diagram referred to in the description.

The metallic caps, *c* and *d*, support the uprights, *e* and *f*, and are themselves supported by insulators, *a* and *b*. The caps are respectively connected to the circuit and the ground. The uprights are adjustable in the caps to distances from each other corresponding with the voltages of different circuits. The uprights rise parallel to each other for a short distance, and then widely diverge, the divergent branches resting upon insulators, *a'* and *b'*. The uprights are copper rods, and are similar in form.

Referring now to the diagram, at the right of the engraving it is evident that "a discharge of lightning will arc across the narrow space separating the uprights and be conducted to ground. Should the arc persist, it will quickly travel upward between the diverging uprights, *e f*, until lengthened sufficiently to destroy it. This extinguishment of the arc is the result of thermal and electrodynamic actions. When the arc is established, as at *e' f'*, the surrounding air is rapidly heated, causing an upward current of air at that point, which tends to carry the arc with it. In addition to this cause, it is well known that conductors under the influence of an electric current tend to arrange themselves in parallel positions. The arc, *e' f'*, being practically at right angles with uprights, the portion *e'* tends to assume the position of the upright *e*, and acts with the upward current of air in lifting the arc. Similarly the portion *f'* tends to assume the position of upright *f*. Thus any arc which may be formed between the uprights is quickly raised to their divergent portions, and thereby becomes self-extinguishing, both the above-mentioned causes, the thermodynamic and the electrodynamic, coacting to drive the arc upward and extinguish it.



OELSCHLAGER AND SCHROTTKE'S LIGHTNING ARRESTER.

"It is evident that the maximum effect is secured when the thermodynamic influence acts with the electrodynamic to drive the arc upward. This, however, can only be accomplished when the uprights are electrically connected with the circuit and ground, so that the arc is the uppermost part of the path of the current which is flowing. The connections should, therefore, be made at the lower ends of the uprights, for, if they are made above the arc, the electrodynamic would act in opposition to the thermodynamic force."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals—See Introductory.

Lighting.

7604. Novel Features of the Niagara Falls Lighting Plant. Orrin E. Dunlap (Illustrated description). W Elec–Aug 15. 1300 w.

7605. Incidental Points About a Central Station Plant. By a Superintendent (Suggestions upon central station management). W Elec–Aug 15. 1200 w.

*7622. The Use and Economies of Rectifiers for Arc Lighting. John Hesketh (Abstract of a paper read before the Northern Society of Elec. Engs. Inefficiencies of present arc-lighting systems). Elect'n–Aug 7. 3000 w.

We supply copies of these articles. See introductory.

*7623. Electric Lighting in Belfast. Victor A. H. McCowen (Abstract of paper read before the Inst. of Mech. Engs., at Belfast. An exhaustive description of the plant, distribution, gas-engine, power, etc., with some data and discussion). Elect'n-Aug 7. 6800 w.

7628. The Detroit Municipal Street Electric Lighting Plant (Information abstracted from the report of the Public Lighting Commission). Eng News-Aug 13. 1400 w.

*7638. Equalizer Systems of Distribution (Editorial dealing with the present state of the art in the matter of distribution, and what has been proposed with reference to equalizers and compensators or balancers). Elec Rev, Lond-Aug 7. 800 w.

*7640. New Lamps for Old (Illustrated description of an improved glow lamp, with experimental data obtained from a report by Mr. George Annesley Grundle). Elec Rev, Lond-Aug 7. 2200 w.

*7681. Combined Alternating and Continuous Currents. Alexander Russell (Some singular effects that follow the super-position of a direct upon an alternating current and *vice versa*). Elect'n-Aug 14. 1300 w.

*7683. Extensions to Outlying Districts. A. H. Gibbings (Extensions as related to cost and revenue are discussed, and also the advisability of such extensions). Elect'n-Aug 14. 3000 w.

*7693. American Experience with High Voltage Lamps (Review of progress and present status of high voltage lamps in the United States). Elec Rev, Lond-Aug 14. 800 w.

7714. A Modern Village Lighting Plant—Norwood, Ohio. Thomas G. Smith, Jr. (Description of one of the latest installations operating incandescent lamps for street-lighting, by direct constant potential current). Elec Eng-Aug 19. 1000 w.

7782. A Direct-Coupled Gas Engine and Dynamo (Illustrated description). Eng Rec-Aug 22. 450 w.

7794. High-Voltage Incandescent Lighting (Reports from a number of central stations and lighting plants using 220-volt lamps). Am Elect'n-Aug. 1400 w.

†7877. Standards of Light. Edward L. Nichols, Clayton H. Sharp, and Charles P. Matthews (An admirable piece of work, both in style and subject matter. The report represents great labor, by which the unreliability of standards in use is affirmed, and the desirability of a standard consisting of an electrically heated incandescent surface is exhibited. The committee also reports that it is engaged in experiments looking toward the solution of the difficult problem of definition of degree of incandescence of heated carbon, hoping thereby to reach the desired standard. Discussion follows). Trans Am Inst of Elec Engs-April. 23500 w.

7973. The Light of the Future. E. Hospitalier (The ideal light—light with the minimum of heat. The author thinks we are approaching the realization of this ideal). Pro Age-Sept. 1. 700 w.

7981. Electric Lighting of Railway Trains Abroad (Reprint from the *Car.* A short account of the development of this branch of electric installation work). Sci Am Sup-Sept. 5. 2000 w.

*8000. Electric Lighting in Australia. Henry J. Spencer (A brief review of electric lighting matters,—which are not very largely developed in Australia). Elect'n-Aug. 21. 3000 w.

8029. Electrical Plant of the Duquesne Steel Works and Blast Furnaces (Describes the power house, generators, switchboards, plant, etc). Elec Eng-Sept. 2. 2200 w.

†8061. A Complete Test of Modern American Transformers of Moderate Capacities. Arthur Hillyer Ford, with introductory note by Dugald C. Jackson (Complete results of Mr. Ford's transformer tests, which represent the product of all the American makers except two). Bul of Univ of Wis-Vol 2, No 1. 7000 w.

8081. The Cleveland Electric Illuminating Company (Presents the chief features to be found in this plant, with illustrations). Elec Wld-Sept. 5. 1400 w.

*8088. Central Station Extensions. G. L. Addenbrooke (A further consideration of the subject in reply to articles by Mr. Barnard and Mr. Baynes, and outlining facts of interest). Elec Rev, Lond-Aug. 28. 2300 w.

Power.

7582. The Electric Wagon on the Farm (Description, with two elevations, of an electric traction engine for plowing and general farm work, the product of the inventive skill of O. W. Ketchum, of Baltimore, Md). Can Eng-Aug. 1000 w.

7590. Transmission at Rheinfelden. E. Rathnan (Abstract of a paper read before the Verband Deutsch Elektrotechn. Illustrated description). Elec Eng-Aug. 12. 900 w.

7601. Controlling Devices for Series-Wound, Constant Potential, Electric Motors. William Baxter, Jr. (Illustrated description of the principles involved in the construction and operation). Am Mach-Aug. 13. 1800 w.

*7621. Energy Losses in Electric Machines Due to the Armature Current. Otto T. Blathy (Detailed results of recent experiments on the load-loss of a typical dynamo). Elect'n-Aug. 7. 400 w.

7667. The Hamburg Combined Electric Power Station (Illustrated detailed description). Eng Rec-Aug. 15. 1500 w.

7728. On the Use of Small Electric Motors. N. S. Stevenson (An excellent practical article of value to purchasers of small electric motors). Am Mach-Aug. 20. 1700 w.

7793. Alternating Current Motors. Dugald C. Jackson (Abstract of a paper read before the Northwestern Electrical Association, in July, with data and curves of tests of polyphase motors). Am Elect'n-Aug. 1500 w.

7836. Starting Box with Under-Load and Over-Load Circuit Breaker (Illustrated description of a needed device). Am Mach-Aug. 27. 800 w.

7849. The Electrical Plant of the Syndicate Building, New York (Illustrated description of the light and power service, operated on the

same 110-volt circuit). Elec Wld–Aug. 29. 2400 w.

7934. How to Make a Simple Dynamo. S. L. Barriett (Illustrated description with full directions). Power–Sept. 2800 w.

*7943. The Utilization of Water Power. Alph. Steiger (Abstract of paper read before the Inst. of Elec. Engrs. The great service water powers are capable of rendering in the cheap production of electrical energy, with description of a few turbine plants under low falls). Prac Eng–Aug. 21. Serial. 1st part. 1600 w.

8027. Why the Armature of An Electric Motor Revolves. D. L. Barnes (From the Baldwin-Westinghouse catalogue of electric locomotives. Explanation of the cause of the movement). Elec Rev–Sept. 2. 2500 w.

8028. The Big Cottonwood Power Transmission, Utah (Illustrated description). Elec Eng–Sept. 2. 1600 w.

8079. On the Seat of the Electro-Dynamic Force in Ironclad Armatures. Townsend Wolcott (Theoretical consideration of the question advanced by Messrs. Houston and Kennelly in a previous article). Elec Wld–Sept. 5. 1200 w.

8090. Transformers. G. W. F. (A study of the apparatus and the principles governing its action, with the electrical, magnetic and mechanical features of the design and construction). Can Elec News–Sept. Serial. 1st part. 2500 w.

*8092. A Non-Synchronous Two Phase Alternate Current Motor. Ernest Wilson (Experiments with the object of investigating the currents in the armature conductors and their effects upon the magnetic field of the motor). Elect'n–Aug. 28. 2500 w.

8115 The Testing Department of the General Electric Company's Works. Theo. Straus (Illustrated description). Elec Eng–Sept. 9. Serial. 1st part. 1500 w.

Telephony and Telegraphy.

*7680. The Apostoloff Automatic Telephone (General description of an invention designed to supersede the special telephone operator and permit the subscriber to control cross connections at the central exchange). Elec Eng, Lond–Aug. 14. 1200 w.

*7688. Telephonic Communication Between Light-Vessels and the Shore. Charles A. Stevenson (General description and remarks upon Prof. Blake's apparatus and system, declared to be efficient). Elec Rev, Lond–Aug. 14. 1000 w.

7804. The Gebrueder Naglo Equipment of Telephone Exchanges—System Hess-Roverot-West. Jul. H. West (Illustrated detailed description of this new French system of connections for central stations on the principle of arithmetical combinations. From advance proof sheets of the *Electrotechnische Zeitschrift*). Elec Wld–Aug. 22. 4800 w.

7807. Improved Telephone Switchboard (Illustrated description of invention of Edward L. French). Elec Wld–Aug. 22. 275 w.

7996. Telephone Cables. Dr. V. Weitlisbach (The article deals with talking through cables and cable construction. The difficulties and how to overcome them). Elec Engng–Sept. 3700 w.

7997. The Air-Drying Process for Telephone Cables. Dr. V. Wietlisbach (Principles of the process, method, plant, apparatus, &c). Elec Engng–Sept. 2000 w.

Miscellany.

*7569. The Shifting Lines of Industrial Interest in Electricity. George Herbert Stockbridge (Tracing electrical evolution, from the lightning rod, through the voltaic pile, to the telegraph, the telephone, and electrical transmission of power). Eng Mag–Sept. 4200 w.

7585. Wire Insulation. H. W. Nelson (Remarks calling attention to a backward branch of electrical work, with suggestions for improvement). Can Elec News–Aug. 1100 w.

7586. Improvements in Thermo-Electric Batteries. James Asher (Methods devised by the writer, for securing good economy in the Clamond type of thermo-electric, which uses no water and which has a chimney). Elec Rev–Aug 12. 1700 w.

7589. On the Proper Use of Safety Fuses and Magnetic Circuit Breakers. William Baxter, Jr. (Discusses the proper place for blow-out fuses, and shows that they are not necessary in the main circuits of central stations and isolated plants). Elec Eng–Aug 12. 1500 w.

7591. Therapeutical Effects of Currents of High Frequency. A. d'Arsonval (From *L'Industrie Electrique*. Preliminary report of some very exact experiments which are being undertaken in Paris, and which promise results of great value). Elec Eng–Aug 12. 1200 w.

*7607. Some Notes on Electrotyping, Plating and Gilding. J. Warren (Hints for the guidance of amateurs and learners). Elec, Lond–July 31. 2300 w.

*7620. Dispersion. Oliver Heaviside (An inquiry into some obscurities and inconsistencies which the author finds in Helmholtz's theory). Elect'n–Aug. 7. 2800 w.

*7659. The International Congress of Electricians in Geneva (Editorial, reviewing the principal features of this congress, opened Aug. 4, and introductory to a full review of the proceedings). Engng–Aug. 7. 1800 w.

*7684. The Electrical Transformation of the Energy of Carbon (An editorial review of the attempts, failures, and partial successes in this field of invention). Elect'n–Aug. 14. 1200 w.

*7689. Analysis of Transformer Curves. W. G. Rhodes (Mathematical analysis of curves obtained by C. K. Huguet of Tulane University). Elec Rev, Lond–Aug. 14. 700 w.

*7690. The Seat of Electro-Dynamic Force (Account of, and remarks upon experiments performed by Houston and Kennelly). Elec Rev, Lond–Aug. 14. 1000 w.

*7691. Lighting Circuits for Electro-Therapeutic Requirements. E. Meylan, in *Revue Internationale de l'Electricité* (A universal transformer for alternating current. Illustrated description with prefatory remarks upon require-

ments for the utilization of electricity in therapeutics). Elec Rev, Lond–Aug. 14. 2100 w.

7712. Electrical Features of the Geneva Exposition (Illustrated description). Elec Eng–Aug. 19. 1900 w.

7758. Electric Furnaces and the Conversion of Carbon into Graphite. Translated from *Le Genie Civil* (Review of the principal models of electric furnaces, with illustrations). Sci Am Sup–Aug. 22. 2600 w.

7759. Lightning Arresters. W. R. Garton (Read before the Northwestern Electrical Assn. A general dissertation upon the principles and different forms of lightning arresters). Elec Rev–Aug. 19. 2800 w.

7775. Some Electrical Features of the United States Battleship "Indiana" (Illustrated detailed description). Elec Wld–Aug. 15. 2300 w.

7788. Electricity in the United States Navy. Frank W. Roller (Consists chiefly of illustrated descriptions of marine electrical appliances). Am Elect'n–Aug. 2500 w.

7789. Transformer "Leakage Current." Dugald C. Jackson (Leakage current no longer a criterion of losses in transformers. Data and directions for testing transformers are appended). Am Elect'n–Aug. 1400 w.

7790. On Röntgen Ray Apparatus Operated from Alternating Current Circuits. Edwin J. Houston and A. E. Kennelly (Illustrated description of a method whereby excellent results may be obtained from an alternating-current incandescent-lighting circuit, the recharging of cells being in this way obviated). Am Elect'n–Aug. 1100 w.

7792. Modern Armature Windings and Connections. Cecil P. Poole (The general principles that govern all armature windings being first enunciated, the author gives illustrated descriptions of modern armature windings). Am Elect'n –Aug. 2000 w.

7795. Construction of a Tesla-Thomson High Frequency Coil. A. F. McKissick (Illustrated description). Am Elect'n–Aug. 600 w.

7796. Interior Wiring (Switch control in buildings is the topic discussed. Faults in position are pointed out and proper methods described. Diagrams illustrate the text). Am Elect'n–Aug. 1600 w.

7797. Faults in Dynamos (Mistakes in armature connections are illustrated by diagrams and described in the text). Am Elect'n–Aug. 1400 w.

7801. A Biographical History of Electricity (Franklin's work is reviewed). Am Elect'n–Aug. 1300 w.

7810. Electrical Bottle-filling Machine (Illustrated description). W Elec–Aug. 22. 1100 w.

7811. Electrical Equipment of the University of Wisconsin (Illustrated description). W Elec –Aug. 22. 1800 w.

7819. Statistics of the Association of the Elektricitaets-werken for the Fiscal Year 1894–95 (This extensive table gives the names of the principal European cities wherein electric installations have been placed, with their population, name of the electricity works, character of management,—municipal or private,—date of starting works, system of current distribution, charges for light and other uses, with statement of the municipal or private management of gas lighting, if used, in each city). Elec–Aug. 26.

7848. On the Multiplicity of Brushes in Large Generators. William Baxter, Jr. (Favors the employment of the two-brush machine, as a substitute for multiple brush machines, with reasons for the preference). Elec Wld–Aug. 29. 1700 w.

7850. An Apparatus for Testing the Magnetic Permeability and Hysteresis of Iron (Illustrated description of apparatus exhibited by Professors Ayrton and Mather at the Royal Society *Soirée*, June 10). Elec Wld–Aug. 29. 900 w.

7972. A Few Points in Relation to the Construction of Commutators. F. J. Turner (Directions illustrated by diagrams). Am Mach–Sept. 3. Serial. 1st part. 1200 w.

7980. The Quantitative Analysis of Metals by Electrolysis (Illustrated description of Riche's electrolytic apparatus and Classen's electrolytic apparatus, with precautions necessary for carrying on the operation successfully). Sci Am Sup–Sept. 5. 800 w.

*7999. The Cox Thermo-Electric Generator (A brief review of work in this field, with description of Mr. Cox's invention). Elec Rev, Lond–Aug. 21. 2000 w.

†8024. An Analysis of Transformer Curves. Charles K. Huguet (Experimental investigations conducted by the writer in Tulane University, with discussion). Trans Am Inst of Elec Engs–May. 4800 w.

8080. The Load Losses Produced by Armature Currents. Harris J. Ryan (Claiming knowledge, since 1894, of the load losses recently discussed in paper by Mr. Bláthy). Elec Wld–Sept. 5. 900 w.

8084. A Contribution to the History of Electrolysis of Alkaline Chlorides. George Lunge (Discussing the question whether the priority of actual success in this field belongs to Germany or to England). Eng & Min Jour–Sept. 5. 2500 w.

*8087. Lightning Protecting Devices for Heavy Current Installations (Contributions from various electrotechnical societies to the question how heavy current installations can be protected from the danger of lightning. Experience of German institutions). Elec Rev, Lond–Aug. 28. Serial. 1st part. 1300 w.

*8093. The Standard Mercury Ohm of the Physikalisch-Technische Reichsanstalt. Wilhelm Jaeger (A summary of investigations undertaken with a view toward the preparation of legal mercury standards of electrical resistance for Germany). Elect'n–Aug. 28. 4000 w.

8107. Liberality of Mind Among Electrical Engineers. R. D. Williams (Charges a spirit of illiberality against electrical engineers as a class, and in the matter of imparting information). Am Mach–Sept. 10. 900 w.

8116. The Manufacture of Chemicals by Niagara Power. Orrin E. Dunlap (Description of plant and processes of the Chemical Construction Company). Elec Eng–Sept. 9. 1500 w.

INDUSTRIAL SOCIOLOGY

An Industrial Democracy.

WE have found the perusal of an article by C. R. Richards, in *Pratt Institute Monthly*, so interesting that we feel it ought to be mentioned in these reviews. The article is too long to be reprinted, and we must be content with an abstract of it. It is a description of the industrial organization in the works of the National Cash Register Company, Dayton, Ohio, which appears to amply justify the title of the article.

"One of the first steps" in organizing the working force in the factory "was to replace the superintendent by a committee of five heads of departments, upon whom the responsibility of the factory management was placed. This principle was afterward extended to sub-committees of foremen and sub-foremen, upon each of whom the largest possible amount of responsibility and initiative was placed, and who to a large extent settled all matters within their own immediate province. These different committees are very similar in their functions to congress and the State legislatures, the head committee making rules and effecting decisions which serve for the guidance of the entire establishment, and the minor committees having jurisdiction within their special domains.

"To extend still further the principle of individual initiative, an autographic register is placed in every department of the factory, on which the employees are invited to write suggestions or criticisms that may be of service in the conduct of the business. For the best suggestions prizes are awarded. Last year these amounted to six hundred dollars. To each one of the prize-winners a diploma of award is given, and his name is added to a permanent roll of honor which hangs in a conspicuous place in the main factory building. The presentation of these prizes is always an occasion of some importance. All the employees are gathered together, and speeches are made by the officers of the company. From this system of awards have been gained substantial advantages. Many of the suggestions so secured have proved of direct financial benefit to the company, in the way of either lessening the cost of manufacture or improving the construction of the machines. The plan has encouraged the men to read, observe, and think, and has been a beneficial influence in educating and broadening them.

"The payment of high wages is also an integral part of this system of individual incentive; for the company have found that nearly all workmen increase their daily output when sure of an increased return. In this way the entire establishment has been converted from a mass of more or less irresponsible workers into a hive of workers and thinkers, each one of whom is inspired with the effort to benefit his own position by benefiting the company." The result has been a notable improvement in quantity and quality of production. But there are other notable and interesting innovations. The employees of both sexes are taught how to take care of their health, by oral instruction, and by a semi-monthly paper published by the concern. Twice a day all hands take a course of calisthenic exercise. Baths are supplied, and each employee may bathe once a week in the company's time. The women are permitted to commence work an hour later in the morning than the men, and to leave fifteen minutes earlier at night. At the time of the calisthenic exercises in the middle of each half-day, they spend five minutes in the exercise, and have, in all, fifteen minutes' recess.

"Every woman employee is also given a half holiday on Saturday, and in addition a whole holiday each month. They work in clean, airy rooms, separated from the men, under forewomen of high character. Rest rooms, furnished with cots, are provided in each department, and clean aprons and sleeves are supplied by the company. Each department has a colored janitress,

and at the noon hour hot coffee, tea, and soup or some other nutritious food are furnished to women employees. The average cost of these lunches is about three cents each, and it has been found that, by reason of them, each woman does one-twentieth more work each day. This amounts to five cents apiece, making the gain two cents, or 66⅔ per cent. When this feature was instituted, an instant improvement in the general health of the women was noticed. There were less delays from sickness, fewer absences, and an ability to work harder and more enthusiastically than when they ate cold food."

Instruction in cooking in outside weekly classes is also given to the young women who desire it, the company giving them the necessary tickets.

"One of the rules of the company is to employ no young women who are not graduates of the high school. They have found that, when the hours of labor are shortened and safeguards to health adopted, persons of education and superior mental power are immediately attracted to the work, and it is easier to retain them after they have become skilled. From a purely financial standpoint, they find that the same number of young women turn out more work of a better quality, at a less cost to the company, than was ever done under former conditions. A committee of five of these young women is appointed to take charge of flags, floral decorations, landscape gardening, etc., about the factory."

A training school for members of the selling force, in which each spends a month before entering upon active duty is another unique feature of this altogether unique organization. In reading Mr. Richards' account of it one recalls the divine humanity of Leviticus, XIX, 9, 10, 13. The article closes with an extract from an address delivered by the president of the company before the Present Day Club of Dayton, January 28, which we cannot forbear quoting.

"Our system is the new factory system, and is as great an improvement over the old as the new high school is over the old high school. Under the old system too much merit in an employee was sidetracked before it came to the notice of the officers; the workmen were nearly all eye servants, who did their best only when a foreman was watching, and those who were dull and slow did not get much aid. In the new factory dull ones are awakened to effort by the example of others who were formerly almost as dull as themselves. Our new factory life is an educator which trains workmen to regard the factory as a fine piece of mechanism in which each individual is an important part. The intelligent coöperation required of each person is a powerful aid to good citizenship.

"We were long ago impressed with the idea that many changes should be made in our system, but were timid in taking any new steps. Many prejudices had to be overcome before the strong desire to deal justly with our employees took effect. When we saw that it was not only just, but to our own interest, to adopt a system of mutuality, we gradually made the change. We learned that, in order to gain unusual ends, one must adopt unusual methods.

"We now aim for coöperation and the strength there is in union; and the more we strive for this, the more success we meet. It seems to us, after trying both the old and the new factory system, that in the latter lies the closest realization of the words of Abram S. Hewitt, who said:

"'Beyond all dreams of the golden age will be the splendor, majesty, and happiness of the free peoples when, fulfilling the promises of the ages and the hopes of humanity, they shall learn to make equitable distribution among themselves of the fruit of their common labor.'"

The Autonomy of Labor.

UNDER the above title *The Contemporary Review* for August has a thoughtful paper written by Mr. H. W. Wolff. The recent labor congress indicated the power of organized labor,—a militant power which the author speaks of as "fighting trades unionism." But the positions are taken that this power can be exerted only by those who possess it; that it has not helped, and seemingly cannot help, those who need help most,—that is, "the lower

strata" of the industrial community; that "it merely corrects a faulty distribution of profits without adding to the profits to be distributed;" and that "it disturbs, rather than steadies, the movement of the industrial machinery, and sometimes shatters the prize for which it is contending, even in the very act of winning it."

It therefore covers too narrow ground. It has done nothing for unskilled labor. The great army of the "sweated" remains as large as ever, and as "sorely oppressed as ever." This class of workers has not the militant power of organized trades-unionism. It cannot enforce demands by refusing supply. It is "abjectly helpless" in its present condition. Yet Mr. Wolff does not regard its state as hopeless; it still has resources which are pointed out, and illustrated by industrial movements in France and Italy. Of course the "army of the sweated" here specially referred to is the lower laboring population of the United Kingdom; but the examples of improvement effected by organized action in France and Italy are worthy of the consideration of all who, in any land, desire the amelioration of the condition of the humblest toilers.

The cause which produces sweating is the command of excessive power in the hands of an unscrupulous middleman. The truth of this proposition has recently been exemplified in the tailors' strike in New York city. The most natural remedy is the one that reaches the cause, or, as Mr. Wolff puts it, "either to reduce his (the middleman's) power, or else to get rid of him altogether." How this was done in France in one instance is recounted.

"Some humble stone-breakers . . . sweated and very helpless—having neither capital nor a trade union at their back—resolved to endeavor to emancipate themselves from their employer's power. Their employment was to break disused paving stones into macadam for the municipality of Paris, in the pay of a private contractor, who received the contract from the town council, according to a standing usage." For this they received only from three francs to three francs and fifteen centimes per cubic meter out of the five francs and fifteen centimes per cubic meter allowed to the contractor, who thus pocketed forty per cent. of the full price paid by the municipality, without risk or serious work. "The men applied to the municipality for the contract direct," and they got it after careful consideration of their application. They have given full satisfaction, are now awarded the contract triennially, and are receiving two francs per cubic yard—about sixty-six per cent.—more for their work than they did under the middleman's employ.

Clearly, the middleman was in this case of no use, except to himself. The men have now laid by a combined capital which will soon enable them to graduate from stone-breakers into the more profitable trade of road-makers.

This is cited as in striking contrast to the methods of militant trades-unionism. The men "have become their own masters. . . . They can go to bed at night with a quiet mind, secure of their position and their employment. . . . Responsibility, quickened by personal interest, has put them on their mettle. They have become better and more competent men,—something of an aristocracy among their own class. They freely admit new-comers. Poverty need not stand in the way, for a man can easily make up the value of his share out of his earnings. But the new-comer must be trustworthy and respectable. Thus in two ways has this little association become a power for good among its own class of workers. It raises wages and it raises character."

The example has been followed by other associations in the same craft and in kindred crafts. In Italy the same sort of combination has been effective in removing the disabilities of workmen. Interesting instances, which ought to be given wide publicity, are set forth, but we refer readers to the original paper for these. The author concludes with an earnest exhortation to leaders in labor movements to study a system of organization which invites no hostility from communities wherein it has been carried out, but, instead, is greeted with friendly sympathy and cordially welcomed.

The Crime of 1896.

THE first article in *Gunton's Magazine* for September has the above title, a paraphrase of an expression frequently made use of by the advocates of silver. The crime charged is that of an attempt to reduce wages. This reduction of wages would follow free coinage. The sound principle that wages are properly measured only by the amount that can be purchased by them is the basis of this proposition. The names of coin or other representatives of value do not determine their value, which can be proved only by the quantity of merchandise or other property which dealers in the open market are willing to exchange for the coin. Robinson Crusoe, on his desert island, had plenty of money; but all he had could not purchase one thing that he desired. His money was therefore valueless to him, although, counted in the usual way, it was a large sum. If he had been surrounded with merchants offering to sell him everything he wished, he would have been obliged to part with as much of this treasure as they might have been pleased to ask for their wares, and this would have been the proper measure of his wealth, in that market.

The article reviewed starts out with the proposition that "the highest crime against national prosperity is to strike down wages, and the most criminal method of reducing wages (because the most insidious and far-reaching) is to debase the standard money in which wages are paid." Upon this proposition are based the following arguments.

"Against actual reductions of money wages by individual employers or corporations, laborers can have recourse to the ordinary means of economic defence through organized resistance, but against the slaughter of wages through debasing the money laborers receive the methods of organized labor are impotent. The evil comes, not in a reduction in the amount of wages laborers receive, but in a reduction in the amount of welfare the wages will buy. Debasement of the standard money steals from the laborer the substance of his wages without changing the form. It silently increases his poverty without reducing his income. This masked assassination of real wages, like the destroying angel of old, in a single night smites every laborer's household. No other industrial scourge is as universal or as sudden as this. All other forms of industrial disaster follow the lines of certain industries or geographical sections, and are more or less gradual in their coming; but this weapon of poverty strikes every laborer in the land at a single stroke."

No one supposes that wages will rise in advance of the adoption of free coinage, or from the anticipation of an advance in prices effected by the success of the free coinage policy. All history shows that the result will be a general and immediate rise in prices of commodities as measured by silver. As measured by gold, general prices will remain substantially what they are now, barring the ordinary fluctuations. But all history shows that the price of labor remains at a standstill till a notable rise in general prices has been made, and that, thereafter, a lead in prices always remains, against the price of labor. Moreover, history shows that, while the prices of merchandise and other property, immediately rise with the depreciation of the currency, advances in wages are reluctantly yielded by employers, and are secured only by the persistent effort of wage-earners, usually involving severe labor disturbances with their attendant distress. This sort of thing (not the prosperity blindly predicted by the advocates of free silver) is what is to be reasonably anticipated, if the lessons of history, as logically interpreted and applied to the present critical period, are ignored.

The first reduction in wages would probably be not less than forty-nine per cent. For a time this would have to be endured by every skilled workman and by every unskilled laborer in the United States. After a while this percentage would be lessened by advance in wages, but its total obliteration would form an entirely new precedent in industrial history. Nothing in the past justified such an expectation. The scheme (of free coinage at sixteen to one) has not even the "seeming excuse"

that it has behind it "an abstract theory of equitable commercial relations." . . . "It has behind it neither history, economic theory, nor financial judgment. It is a scheme whose sole purpose is to strike down wages in order to double the profits of a small and special class. . . . Thus to strike down wages is to destroy nearly half the consuming power of over fifty millions of people, and with it destroy the very basis of prosperity in every form of productive industry. The farmers who are expecting to gain by this sacrifice of the laborers will soon find that the promised profit is a mere mirage. The chief market for the products of American farmers is consumption by the wage and salary-receiving population employed in the manufacturing and commercial industries; let this be reduced fifty per cent., and all hope of improvement for the American farmer is gone. There is no chance for increasing his sales abroad. India, Argentine, Russia, and Austria can beat him there. Let American markets be destroyed, and the abyss of agricultural depression will be at hand, and unsold crops, foreclosed mortgages, deserted farms, and agricultural desperation will be realized.

"Whatever may be the theories of farmers regarding prices, they cannot afford to destroy the markets for their products. Whatever may be the theories of laborers regarding capital, public ownership of industries, or the reconstruction of society, they cannot afford, under any circumstances, to permit a wholesale reduction of wages."

The Philadelphia Commercial Museum.

AMONG the important organized efforts to extend the foreign trade of the United States the institution named in the title merits attention. While its benefits must in their nature be of national extent, the enterprise is supported by Philadelphia, which has thus initiated a work from which the commerce of other cities will gratuitously profit. In this institution will be studied the foreign commerce of all lands, and extensive data will soon be acquired and placed at the command of all the industrial interests of the country. To this end arrangements have been made for constant communication with all export markets and for the collection, preservation, and exhibition of samples of products from all parts of the world.

The Manufacturer's Record (Aug. 14) details the purposes of the bureau, an important function of which will be "to advise concerning the commerce of all countries, their customs and commercial relations, their international treaties, their systems of communication and transportation, with special details of freight lists and tariffs, exchanges and currency. It is the purpose of this department to be sufficiently broad in its scope to command the good will and coöperation of all manufacturers, bankers, commission houses, transportation companies, and all others interested in the development of our foreign trade.

"The manufacturer or dealer who desires to import the raw products of foreign countries, such as woods, hides, skins, food products, etc., will be shown the samples in the museum, and, through this bureau, will be advised as to the prevailing prices in the country of origin, the means and cost of transportation, quantity available, and conditions under which the particular products desired can be procured.

"The manufacturer who wishes to introduce his goods into new markets abroad will be shown samples of whatever is now salable in those markets. Full details as to the competition he may have to meet will be furnished him as follows:

"(1) Character and variety of goods demanded in various markets; (2) the country from which imported, together with the names and addresses of foreign manufacturers, where possible; (3) the quantity imported annually into each particular city; (4) the manufacturers' prices at the factory; (5) the retail prices in each city where sold; (6) transportation charges from Europe to the various foreign ports, compared with rates from the United States; (7) import duties; (8) character of packing; (9) the names and addresses of importers.

"The bureau will also collect detailed information concerning all public improvements in progress or contemplated

in Spanish America, South America, and other new export fields, which may be of interest to the commercial classes of the United States.

"A commercial library will be maintained, consisting of statistical publications of our own and foreign countries, maps, charts, and all prominent trade publications of the world; also official copies of the import and export duties of all foreign countries."

Emigrant Agencies.

THESE agencies are denounced by *The Board of Trade Journal* for August as "a special snare to intending (English) emigrants." Many abuses are constantly coming to the knowledge of the emigrants' information office, mainly in connection with what is called the "farm pupil premium system." Under this system certain agencies are said to have become notorious. They undertake to find situations for young men on Canadian farms, and on farms in the United States, receiving for their *quasi* services specified fees, which "are in all cases unnecessary, and in some cases simply fraudulent." The evil has grown to such dimensions that the Canadian press has commented severely upon it, and the Canadian steamship companies have severed their connection with these agencies. This action on the part of the steamship lines is perhaps creditable, but, as they must have previously known the character of the agencies, it would have been more to their credit to have severed the connection before the public exposure of the frauds. No doubt this will fail to much embarrass the agencies, which can easily transport their victims *via* United States ports, at somewhat greater expense. The *Board of Trade Journal* says that "the evil is hard to deal with, for there is no reason to impugn the good faith of many companies of this kind, and in other cases absolute proof of a criminal offence, such as fraud or obtaining money under false pretence, is rarely forthcoming. The quotation below illustrates the abuses which the system fosters. It refers to a party of young emigrants who were induced by one of these agencies to go out to Kansas, in company with some who stopped in Canada, those who remained in Canada having paid a fee of £25. while those who went further fared worse, having paid an agency fee of £45. These fees include their fares to Toronto, *via* Montreal, leaving in the hands of the agency about seventy-two dollars for which it gives no real consideration. Yet there is a pretence of service which the following quotation explains.

"Each young man pays to an agency for service in placing them on a farm to work, the same as farmers' sons, on the following terms:

"The first six months for nothing, the next twelve months for five dollars a month, and then for what they are able to obtain. The young men have had to pay their hotel expenses during their journey. They are of the better class, and several very well educated.

"In nearly all cases the young men are grievously disappointed, expecting to be placed on first-class farms, which, however, is seldom done, the farms allotted to them having very poor accommodation, and consequently they eventually drift back to the cities, where they fail to find employment, and thus swell the already large numbers of distressed British subjects."

The following is from a recently-published report of the British vice-consul at Kansas City:

"During 1895 over sixty young men were sent into this vice-consular district under false pretences from Great Britain; in every case they came through unreliable employment agencies in London; they were sent here under the pretext of their being apprenticed on large stock farms, for which they paid money in advance. After arrival here they were placed on small farms, and in some cases not provided with work, but left to the mercy of strangers, which forced them to seek advice and assistance from the vice-consul. Such employment agencies should be investigated and suppressed."

When the depressed state of the farming interest in the United States is re-

called, it is evident that the misrepresentations which induce young men to come here to engage in farming must be shamefully gross.

Rights and Duties.

J. S. MACKENZIE in *International Journal of Ethics* says that man at least is a teleological animal, guided by the idea of an end; and the struggle is more for *rights* than for *existence.* Consciousness of justice is one of the most important elements in making a people strong. Man struggles partly to live, but much more to live well, which means to develop an infinity of relations with the world. The ethical end is best described as the realization of a rational universe. There is no other injustice than to be balked in efforts towards the full development of capabilities by any other cause than the limitations of nature or the claim of other men to a similar development. When the objects to which we relate ourselves are other human beings, we have a right to certain services from them, they have a corresponding right to services from us. From our standpoint, the former are rights, the latter duties. A claim which any individual possesses may be regarded as conveying with it an obligation upon that individual himself. Rights and duties are two aspects of our powers, but they depend not only on our own powers, but on the nature of the things to which our powers are related. The power of ruling gives no right, if there is nothing that wants to be ruled over. There are no natural rights or duties. They are progressive in nature. No man can leap to the goal of human perfection singly. He must take the world with him; and the world moves slowly, making the stages of its advance by establishing definite laws and customs. If these are taken merely as representing the solid part of what has hitherto been done, we may use it as a basis for further work. In criticising rights, and obligations, it should be presupposed that the world is not altogether a fool. Little that is found in law or morals which have stood the strain of centuries of human activity is without some firm foundation in the nature of man.

MALLOCK, the English essayist, combats Hobson's assertion that poverty is on the increase. He holds that the incomes of the poor have constantly increased ever since the establishment of the capitalistic régime, and that incomes of both poor and rich have grown faster than individual riches.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

*7563. Free Silver Poison the Cause of Industrial Paralysis. J. Selwin Tait (Showing how debasement of the coinage would affect the savings bank depositor, the shareholder in building associations, the members of insurance companies and the farmers). Eng Mag-Sept. 3300 w.

†7575. The Autonomy of Labor. Henry W. Wolff (The Italian labor organizations are, among other European societies, shown to have been most effective in good results. Descriptions of some of the principal societies and their operations are given). Contemporary Rev-Aug. 7500 w.

7630. Exporting American Manufacturers (Description of the plans of operation of three different organizations for promoting American commerce abroad; namely, The Exporters Association of America, the National Association of Manufacturers, and the Philadelphia Museum). Eng News-Aug. 13. 3500 w.

7636. Some Historical Facts as to Protection (Editorial argument for the protection of American industry by a customs tariff). Mfrs Rec-Aug. 14. 1700 w.

7637. An Important Work in Finding Foreign Markets for American Manufactured Products (The character of the Philadelphia Museum, its purposes and methods). Mfrs Rec-Aug. 14. 400 w.

*7744. Dangerous Trades (Editorial review of the report of a committee of the British Home Office, showing that the amelioration of the dangers to health incurred in various trades, is a matter of national importance in its relation to the physique of future generations). Engng-Aug. 14. 1500 w.

7787. Municipal Ownership. John A. Britton (Municipal ownership is treated adversely and considered as a disease upon the body politic. Discussion). Am Gas Lgt Jour-Aug. 24. 6000 w.

†7864. Convict Labor (Account of an investigation by the Dept. of Labor, made with a view of bringing recent facts relating to convict labor into comparison with those collected in 1886. Valuable statistics). Bul of Dept of Labor-July. 9000 w.

We supply copies of these articles. See introductory.

†7865. Recent Reports of State Bureaus of Labor Statistics (Abstracts of reports for the states of Maryland, Michigan, North Carolina and Massachusetts). Bul of Dept of Labor–July. 2400 w.

†7866. Recent Foreign Statistical Publications (General review of European statistical literature for current month). Bul of Dept of Labor–July. 3500 w.

†7873. Bi-metallism and the Nature of Money. W. H. Mallock (The difficulty with which the bi-metallists have set themselves to contend is herein explained, with the aid of simple diagrams). Fortnightly Rev – Aug. 7000 w.

†7880. From a Silver to a Gold Standard in British Honduras. Alfred Moloney (The beneficial effects produced by the change from stlver to a gold currency in the country named are clearly stated). N Amer Rev–Sept. 3000 w.

†7881. Are the Farmers Populists? John M. Stahl (The question is answered negatively, and the history of the United States is cited to sustain the answer). N Amer Rev–Sept. 4500 w.

*7902. Warning to Intending Emigrants (Issued by the Emigrant's Information Office. Discredits the English emigration agencies and land companies, which, while they confine their operations within legal bounds, are said to obtain large amounts from emigrants for which no equivalent in service is given). Bd of Tr Jour–Aug 1500 w.

*7903. Customs Tariff of British Guiana (Rates now levied on imports into this colony, and list of articles exempt from duty). Bd of Tr Jour–Aug. 1700 w.

*7904. Tariff Changes and Customs Regulations (Russia, Norway, Germany, Belgium, France, Madagascar, Spain, Roumania. Italy, Austria Hungary, United States, Mexico, Costa Rica, United States of Colombia, Brazil, Uruguay, Argentina, Chile, British India and Canada). Bd of Tr Jour–Aug. 5400 w-

7979. An Industrial Democracy. C. R. Richards, in *Pratt Institute Monthly* (Describes an interesting industrial system in operation in the works of the National Cash Register Co. at Dayton, Ohio). Sci Am Sup–Sept. 5. 2200 w.

8014.—$1. Uncertainty as a Factor in Production. E. A. Ross (The causes of uncertainty and the range of variation in the output of many industries, with their social and economic effects). An Am Acad–Sept. 9000 w.

*8018. Fallacies About Gold and Silver (The assertion that silver has not decreased in value per ounce but that gold has risen, one of the most difficult points in the present discussion to deal with, and susceptible of ambiguity on either point of view, is ably refuted). Gunton's Mag–Sept. 4000 w.

*8019. Macaulay on American Institutions (Macaulay's famous prediction as contained in a letter (1857) to Hon. Henry S. Randall (letter reprinted) is here made the subject of editorial comment. The prediction is held to be verified in this year's political situation in the United States; but the cause assigned by Macaulay is held not to be the right one. Freedom alone is not sufficient to make a nation prosperous, happy and intelligent. The conditions of industrial prosperity and social progress must also be wisely guarded). Gunton's Mag–Sept. 2500 w.

*8025. An Outlook Upon the Agrarian Propaganda in the West. Newell Dwight Hillis (The author thinks the present industrial depression is explained by other causes than the appreciation of silver. The rise and progress of sectional feeling, based upon the belief that demonetization of silver is the cause, is reviewed). Rev of Rev Sept. 1800 w.

*8026. Would American Free-Coinage Double the Price of Silver in the Markets of the World? I. The Affirmative View. Dr. Charles B. Spahr. II. The Negative View. Prof. J. Laurence Laughlin (A symposium. Part first considers the effect of free coinage of silver by the United States upon the gold price of silver bullion. Part second replies to Dr. Spahr, pointing out discrepancies). Rev of Rev–Sept. 5000 w.

8035. German Export Methods (Review of a new book—"Made in Germany"—describing German methods, their results and their relations to the extension of American commerce). Eng News–Sept. 3. 1900 w.

*8056. Are We Becoming a Homeless Nation? John O. Yeiser (Reference to numerous authorities, including the census of 1890, leads to the conclusion that only 7½% of the people of the United States own the land on which they live). Arena–July. 2200 w.

*8057. Is the West Discontented? Is a Revolution at Hand? John E. Bennett (Reply to an article by J. H. Canfield, the present chancellor of the University of Nebraska, entitled, "Is the West Discontented? A Study of Local Facts." Mr. Bennett refutes the optimistic conclusions of Mr. Canfield). Arena–Aug. 5500 w.

*8058. Associated Effort and Its Influence on Human Progress. Dr. M. L. Holbrook (Association is the basis of social evolution. The proposition is supported and illustrated by examples in the animal and vegetable worlds. This is followed by instances of successful co-operation in human society). Arena–Aug. 7000 w.

*8059. A Remarkable Statistical Report. James Malcolm (Review and summary of a statistical report on taxation issued by the Illinois Bureau of Labor Statistics). Arena–Sept. 2500 w.

†8103. Some Social Economic Problems. Clare de Graffenried (A general review of problems relating to the betterment of the condition of working classes). Am Jour of Soc–Sept. 4500 w.

†8104. The Criterion of Distributive Justice. Frank Chapman Sharp (The aim of this paper is to present such data as may place the reader in position to decide between two criteria of justice: (1). The rightness or wrongness of every action is determined by the relation in which it stands to the well-being of those directly or indirectly affected by it; (2). Reward should be proportioned to individual desert). Am Jour of Soc–Sept. 4200 w.

MARINE ENGINEERING

Inland Navigation in Germany.

ONE of the features of the times is the notable increase of inland navigation in civilized countries blest with navigable streams and lakes. This has been very noticeable in Germany for the past ten years. A new law regulating inland navigation in that country went into effect January 1, of this year, by which authority has been granted to the government to regulate the time of loading, of discharging, waiting, etc., and of fixing the charges for the time in certain exceptional harbors. It has, moreover, decreed that ship registers are to be kept.

The British consul-general at Frankfort-on-Main reports that, in the harbors of the Rhine the traffic has risen from 21,300,000 tons, in 1893, to 24,600,000 tons, in 1894,—*i.e.*, by 15 per cent. At the 34 German Rhine harbors, the traffic rose at the same time from 14,600,000 to 16,700,000 tons. The most important Rhine harbors of Germany showed the following traffic in 1894: Ruhrort, 4,693,198 tons; Mannheim (Rhine and Neckar), 3,662,580; Duisburg, 2,579,738; Hochfeld, 958,105; Ludwigshafen, 754,426; Cologne, 637,216; Gustavsburg, 500,283; Dusseldorf, 354,823; Castel with Amöneburg, 317,197; Mayence, 244,641; Neuss, 209,000; Worms, 173,200; Uerdingen, 159,695 tons.

Canal construction has also been active. At the head stands the Midland canal, as in 1886 the Prussian diet sanctioned the Dortmund-Ems canal, but refused in 1894 to have it continued as far as to the Rhine. The Dortmund-Ems canal already is paying attention to larger ships; it possesses a depth of 2.5 meters, and is intended for vessels of 600 or 700 tons, but is so constructed that ships of 800 to 1,000 capacity will gradually be admitted. The Midland canal is to unite the Rhine, Weser, and Elbe with each other, and is to meet the requirements of the present-day shipping. The Midland canal will not only unite the Rhine and the Rhenish-Westphalian mining and industrial center with the Elbe, but also, by means of the Planen canal, unite with the Markish district rivers the center of Berlin, and by these unite with the Oder; and, by means of the network of the Bromberg canal and the Brahe, will connect with the Weichsel. With its completion there will exist a navigable way from the west to the east of Prussia.

Bremen will soon have an efficient water connection with the middle and west of Germany by the canalization of the Weser as far as Merseberg, and a canal joining the latter with the Midland canal. The canalization of the Main from Frankfort to Offenbach is also mooted in South Germany.

Dangers of Coal-Carrying Through Spontaneous Ignition.

THE cause of spontaneous ignition of coal, which is one of the serious risks to vessels in the coal trade, is, according to Professor Medem, in *Kuhlow's Trade Review*, the presence of iron pyrites in the coal. No coal is entirely free from iron sulphid, and, when present in sufficient quantity and under conditions favoring rapid oxidation and retention of heat, iron sulphid generates heat enough to cause the oxidation or combustion of the coal itself.

It would seem that Professor Medem regards as erroneous the common notion that carbon, *per se*, will absorb oxygen rapidly enough to ignite spontaneously. He states that "a pyrophoric tendency is only manifested in charcoal when some of the volatile hydrocarbons have been left behind in the distillation process and enter into combination with absorbed oxygen. If, however, such charcoal be freely exposed to air, the external portions speedily lose this property, owing to the pores becoming saturated with air, but it will regain its pyrophoric character, if powdered so that the internal layers are enabled to absorb oxygen. As the process of chem-

ical combination only goes on in the interior of a heap, the best way to arrest it is to spread the charcoal out, since the attempts at ventilation by blowing or drawing air through the mass will only result in increasing the combustion."

Pyrophoric charcoal regains this quality every time new surfaces are exposed, until it reaches the state of powder; but powdered charcoal, after a sufficient exposure to air, will not again become pyrophoric.

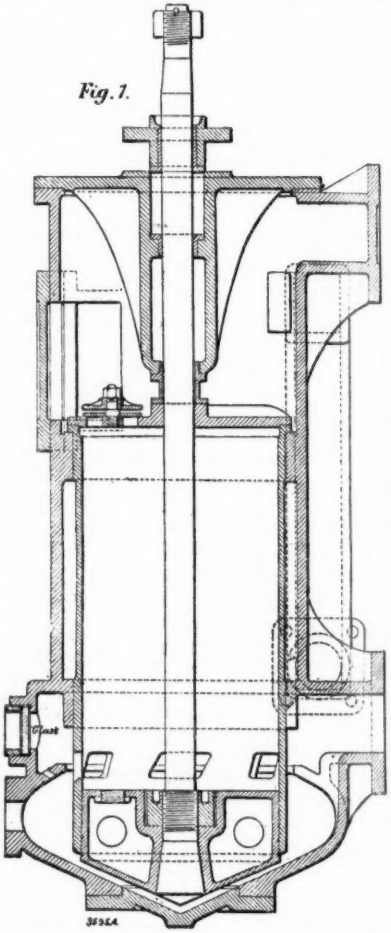
"Hard coals, brown coals, and the like are subject to two dangers, explosion and ignition, each having a separate cause. Explosion is due to the liberation of firedamp following on a decrease in atmospheric pressure, whereas ignition results from the oxidation of the iron pyrites contained in the coal, when exposed to the action of oxygen and moisture. The danger is the greater the finer the state of division of the coal, and coal stacked above ground is particularly liable. Attempts made to reduce the danger by ventilating the stacks have failed in this case also, on account of the increased amount of oxygen thereby introduced into the interior of the mass; and accordingly the coal is stacked as tightly as possible, in order to exclude air. Strangely enough, the practice of ventilating the coal bunkers of ships has not been altogether abandoned, notwithstanding Liebig's impressive warning given as far back as 1866; and neglect in this particular has frequently led to lamentable fatalities. Since 1865 no less than 97 coal-laden vessels have been destroyed and the lives of some two thousand seamen sacrificed through spontaneous ignition of the cargo."

A New Form of Air-Pump.

WE have reproduced the accompanying engravings, which will much interest marine engineering constructors, and have condensed the description of the same from *Engineering* (Aug. 14). The pump was invented and designed by Mr. Frederick Edwards of London, and the design presents the following advantages:

No foot or bucket valves to leak and get out of order; the barrel is shorter; the foot valve seat and the flange which supports it are not required; neither is it necessary to have any door in the barrel. The number of valves and working parts are, therefore, reduced to a minimum, and the only valves are in the most accessible position. It is also claimed that two-thirds of the sources of breakdown and delay are removed, and very much less than one-third of the time is required for overhauling the pump. Fig. 1 is a sectional elevation, and Fig. 2 a plan. The bucket is of a coned form underneath, and it nearly fits the bottom of the chamber. When the bucket descends, it strikes the water lying in the bottom, and the water is in this way

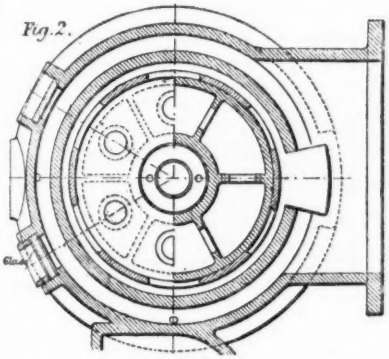
Fig. 1.



forced outwards with considerable velocity, striking the curved part of the outer chamber; this changes its direction, and causes it to flow through openings provided in the barrel just above the bucket, the momentum it acquires being sufficient to carry it well up the barrel. The bucket, on its return stroke, closes the ports before the water has time to recover from its upward travel. By this arrangement the necessity for foot and bucket valves is entirely done away with.

The quantity of water an air pump, working in connection with a surface condenser, has to lift is very small, and, in a good triple-expansion engine, generally varies from ¼ in. to ⅜ in. depth on the bucket; in fact, it is ridiculously small compared with the size of the pump.

Fig. 2.



In Mr. Edwards's pump the admission of the air has been made the first consideration and the water a secondary matter, and the latter tends to help the former. When the bucket descends, the pressure above it is that due to the temperature of the water, and, when the ports first open, there is a free entrance for the air, and there is no water passing through the ports, after which the cone of the bucket strikes the water silently without any shock and sends it up into the barrel. The guiding edge and the ports are so arranged that the top of the water is some distance below the top edge of the ports, which leaves a clear entrance for the air, even when the water is going in; and, at the point where the air comes in contact with the water, the latter is travelling at a rapid rate into the barrel, tending to assist the air. In this pump no pressure is required to open any valves or to drive the water up into the barrel.

Salvage Awards.

ON June 27 the derelict iron bark, Janet, was towed into the Erie basin, Brooklyn, with a valuable cargo of nitrate of soda. It is said that this will give a salvage of some seventy thousand dollars to the crew of the steamer, Innerly, which saved the vessel. This event gives occasion for the *American Shipbuilder* to make some editorial comments upon the subject of salvage in general. Perhaps no matter of a commercial nature involves the possibility of greater complications than a salvage award. In the United States claims for salvage are adjudicated by the United States district court in admiralty session. In England the admiralty division of the high court of justice decided issues arising from salvage claims. As a measure of economy, both of expense and time, "the leading underwriters of the world," says the *American Shipbuilder*, "have been agitating a plan to do away with the intervention of courts in salvage cases and submit them for settlement exclusively by private arbitration."

Few who have not been at some time interested in the outcome of a salvage claim are aware of the complications which may beset the settlement of such a claim.

"In deciding the amount of compensation each case must rest upon its merits. All the circumstances must be considered. The danger to other property or lives, the skill shown and the danger incurred by the salvors, the losses, if any, of the salvors, the actual or possible losses of the salvors, and the value of the property of both parties, are the chief matters to be borne in mind. The apportionment of salvage is a constant source of disagreement between owners and crews of vessels, especially steamships, which have rendered aid to vessels in distress. Sometimes the work done is so much like ordinary towing, when the crew of the rescuing vessel are not called upon to do any tasks beyond

their ordinary work, that the owners feel themselves entitled to all or nearly all of whatever salvage may have been earned. Upon the other hand, masters and seamen frequently form exaggerated ideas of their own merits in a case involving salvage, and expect a lion's share. It is a curious fact that the law does not permit any salvage for saving life. This is because, under the insurance contracts, a vessel is not held to have deviated from her course when she goes out of it to save lives, while, if she goes out of it to save property, her insurance is forfeited, and compensation must be made for its loss. The rule is that salvage services can only be rendered by persons not bound by contract to render them. A crew cannot claim salvage for saving their own ship, not only because it is their duty to save her if possible, but because it would be most unwise to tempt them to let the ship and cargo get into a position of extreme danger that by extraordinary exertion they might secure a claim for salvage. It is the duty of seamen to remain by a wreck so long as it is safe to do so. They have a prior lien to salvors upon everything saved, for their wages. In case of disaster, the master is held to be the agent for the cargo as well as the ship, and is but fulfilling his duty in providing for their safety. Seamen who assist in saving the cargo after a ship is wrecked and the voyage broken up are entitled to extra compensation. If part of a crew leave their ship and go to save another, and thereby acquire a right to salvage, those who remain share in the reward, though not equally, for their rights rest mainly on the increased labor or exposures which fall upon them."

What we have quoted is sufficiently suggestive of difficulty, which, it would seem, a board of sensible arbitrators composed of men familiar with marine affairs could cope with as well as, or even better than, a law court, the difficulty arising mostly from questions of fact, such as juries decide in ordinary civil causes. In this view of the subject, the effort to substitute arbitration for the now usual legal process in courts of admiralty seems commendable.

Detecting the Direction of Sound Signals.

IT is often difficult, if not impossible, at sea, to determine whence a sound, as of a fog-horn, bell, gun, or steam-whistle, proceeds. This effect frequently neutralizes to a great extent the usefulness of sound signals as warnings to vessels in positions of danger. A signal that misleads may prove worse than no signal at all. Hence a device described in *La Nature*, and re-described in *Nature* (Aug. 20), is of present interest. We herewith present a brief abstract of this description, which will serve to indicate the nature and use of the device. Two microphones are placed on board at as large a distance apart as possible, say one hundred yards. Each of the microphones is connected with a telephone. The observer holds the forward telephone to his right ear, and the stern telephone to his left. Then, when a signal is given by a vessel straight ahead, he will hear it first in his right ear and then in his left, and the interval will be that required by the sound wave to travel from one microphone to the other.

In the case supposed about one third of a second would elapse between the two hearings,—a more than sufficient interval for distinction between the two auditions.

When the strange vessel is just abeam, the sounds will strike the microphones at the same instant, and the observer will hear them as coincident. When it is just astern, the left ear will be the first to hear the signal. This method, while capable of fixing the angle between the keel of the vessel and the direction of the stranger, does not decide the port-or-starboard question. This might be done by a similar auxiliary apparatus amidships. Another method described by the same author is based upon the interference of sound waves, the sound being received by a tube dividing into two branches, whose ends are placed at a distance apart equal to half the length of the sound wave, and are attached to the ends of a bar capable of rotating in a horizontal plane. When this bar points in the direction whence the wave proceeds, and only then, will the sound heard through the tube vanish by interference. But the wave may be pro-

ceeding along the bar either forwards or backwards, so that here again we have an ambiguity. But it must be borne in mind that the choice between two exactly opposite directions is comparatively easy.

Probably the first method would be serviceable in locating the direction of fog-horns, bells, whistles, etc., but the second seems too difficult of exact application to be practicable. We have no doubt that electricity will, in some way, prove the key to the problem of accurately determining the direction of sound waves at sea, as it has in the past been the key to the practical solution of many other physical problems.

AN English inventor has succeeded in making field and marine glasses with aluminum tubes so light that, with the aid of a head-band and a peculiar nose-rest that the glasses can be held to the eyes without the use of the hands and with very slight fatigue. This will be a very great improvement, leaving the hands free for making notes, or for signalling, and avoiding the fatigue of the arms in watching the progress of marine races, etc. The nose-rest is padded, and the tubes are maintained steadily in the line of vision. Civil and military engineers will also find this invention serviceable in field-work and reconnaissance.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

7594. The United States First Class Battleship Indiana (Illustrated description). Sci Am-Aug. 15. 1600 w.

7648. Liquid Fuel and Methods of Burning it. Herbert C. Wilson (Abstract of a paper read before the Inst. of Marine Engs., London. General discussion of methods followed by a description of the best means of utilizing the heat of oil fuel for generating steam for machine use). Ry Rev-Aug. 8. 2500 w.

*7656. The Naval Construction Company's Works at Barrow (Illustrated description of a shipbuilding establishment whose annual payment of wages is over $1,600,000). Engng-Aug. 7. Serial. 1st part. 3200 w.

7661. Testing Steel for Marine-Engine Construction (Extract from Foreign Abstracts of Civil Engineers. Methods). Ry Rev-Aug. 15. 1000 w.

*7737. Warping Gear S. S. Algoa (Illustrated description). Eng, Lond-Aug. 14. 400 w.

*7738. The S. S. Jaltra (Illustrated detailed description). Eng, Lond-Aug. 14. 1200 w.

7752. Accident to Dry Dock No. 2—New York Navy Yard (Illustrated description). Sci Am-Aug. 22. 500 w.

7754. The First Class Battleship Indiana (Illustrated description). Sci Am-Aug. 22. 1800 w.

7822. Types of United States War Ships (Brief description of types, from which specific service designed can generally be inferred). Ir Age-Aug. 27. 1300 w.

7839. Are Our Warships to be Run Without Engineers? J. M. C. (Extracts from a communication to the Philadelphia *Public Ledger*, Aug. 14. which show that the costly and extensive machinery of the U. S. Navy, is in danger of neglect from the want of an adequate engineering force to care for it). Am Mach-Aug. 27. 1800 w.

7878.—$1.25. Contract Trial of the United States Coast-Line Battle Ship Oregon. Leo D. Morgan (Illustrated description of the ship and an account of the trial, with data). Jour of Am Soc of Nav Engs-Aug. 9000 w.

*7884. The Steam Yacht "Speedy" (Illustrated detailed description). Engng-Aug. 21. 350 w.

7969. Dimensions of Small Marine Engines and Boilers. J. G. A. Meyer (Directions for designing, which, it is claimed will give good results in most cases, and possibly, not bad results under any circumstances). Am Mach-Sept. 3. 1300 w.

*7998. The Cable Ship "Tutanekai" (Illustrated detailed description of a vessel designed for use in repairing the New Zealand government cables). Elec Rev, Lond-Aug. 21. 800 w.

8040. A Monolithic Beacon Tower, France (Illustrated description of a new light-house at Irvis-Pierres, at the entrance to the harbor of Lorient, France). Eng News-Sept. 3. 1100 w.

*8073. The Waste of Shipping (Data of losses of vessels at sea). Engng-Aug. 28. 600 w.

*8074. The Nippon Yusen Kwaisha (Status of the chief Japanese shipping company. The probable extension of its business). Engng-Aug. 28. 2200 w.

8110 The Bazin Roller Ship (Illustrated description of unique craft launched Aug. 19, from the Cail dock-yards on the Seine). Sci Am-Sept. 12. 800 w.

8111. The Propulsion of Barges. From *La Nature* (Illustrated description of a new method of propulsion by screws, under peculiar and original conditions). Sci Am-Sept. 12. 900 w.

8113. The Launching of Vessels in France. From *La Vie Scientifique* (Processes and material employed in French practice are illustrated and described). Sci Am Sup-Sept. 12. 700 w.

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

The Horseless Carriage.

SPEAKING editorially of the postponement till next year of the thousand-guinea prize competition proposed by *The Engineer* (London), the *Journal of Gas Lighting* says the reasons for the postponement "are very much on the lines of the historic excuses of a local authority for neglecting to ring the town bells in honor of a visiting monarch. As a matter of fact, a satisfactory mechanical road carriage has not yet been produced; and there is very little encouragement for the hope that anything of the kind will be forthcoming either this year or next.

"There are, of course, petroleum road cars and benzoline bicycles, of sorts; but nothing of the kind *in esse* or *in posse* is more likely to supersede the common omnibus, to say nothing of the victoria or the hansom cab, than is Maxim's flying-machine. The condition of the case of mechanical traction as applied to tramway working is quite sufficient warranty for this conclusion. There is no reason whatever why an engine that is competent to drive a road carriage should not in the first place serve a period of probation on the rails; and where is anything of the kind to be seen besides the lumbering steam tramcar, and, very recently, the gas-power car?"

The compressed-air motor now appears as a possibility of the future, unrecognized by our cotemporary, its trial in New York having given very encouraging results as applied to tramway traffic. But the possibility of its use as a motor for carriages on common roads is so remote, and involves so much progress in the general distribution and supply of compressed air, that he would be a bold prophet who should venture to predict its use for this purpose, even in cities, not to speak of country roads. In fact, the journal quoted is about right in saying that the possibilities for general traffic of anything in the way of horseless carriages yet produced are extremely limited. In France it may seem that there is a notable exception,—the Serpollet carriage; but, though this has done some good work on the excellent French roads, a description of its parts shows that the machine is far too complicated a structure for universal use.

The present status of the horseless carriage is summed up in the concluding paragraph of the editorial under review: "All this is far enough from offering even the germ of a satisfactory mechanical road carriage, such as, to use *The Engineer's* sensible test, a busy doctor would like to buy for doing his daily round. It is only when one takes such an example as this, of what is needed in a successful vehicle of the kind, that it is possible to realize how great is the distance that improvement has yet to cover before making such an approach to finality as that attained in the modern bicycle."

Improved Stang Planimeter.

THE planimeter, in this day of indicator diagrams, has become an indispensable instrument to the steam-engine tester. From the complex to the simple it has gone through an evolution, till, in the instrument illustrated and described in *Engineering* (Aug. 14), it appears to have reached an almost final stage of perfection.

"In its simplest form the hatchet, trammel, or keel planimeter consists of a tracing-point and a convex hatchet edge, the point and the edge being connected rigidly together, so that, when the point is moved along any line, the edge describes a curve." It was invented by Capt. H. Prytz, of Aarhus, Denmark.

When in use, the boundary of the figure whose area is to be measured is traced continuously in one direction with the tracer-point, while the hatchet end of the instrument describes a path from which the area can be directly measured.

The author of the article under review, Mr. Ernest Kilburn Scott, was led to design the form illustrated, by the existence of defects in the original form. The improvements are shown in Fig. 1, a side elevation, Fig. 2, an end elevation, and Fig. 3, a plan. The usual hatchet edge of the ordinary form is replaced by a hard steel knife-edged wheel, A; this is done because, if the hatchet is very sharp, it is liable to cut the paper, or stick; and, on the other hand, if it is blunt, it does not give a clear dent, and is liable to slide-slip. The wheel may have an exceedingly sharp edge, and, as it revolves with very little friction, the operator is not so liable to jerk the instrument.

To avoid the inclination of the instrument to one side, which may easily occur with the common form, a flat plate, C, of celluloid, with a small hole, D, at its center, is used as the tracing-point. The plate is kept pressed flat against the paper by the operator, who places his forefinger lightly on the extension, B, and is thus enabled to keep the rest of the hand out of the way. The instrument being thus maintained in vertical position, the boundary line can be very accurately followed, and very accurate readings secured. The method of using the instrument preferred by Mr. Scott is as follows:

Suppose the diagram to be measured to be 2¾ inches long. The wheel,

Fig. 1.

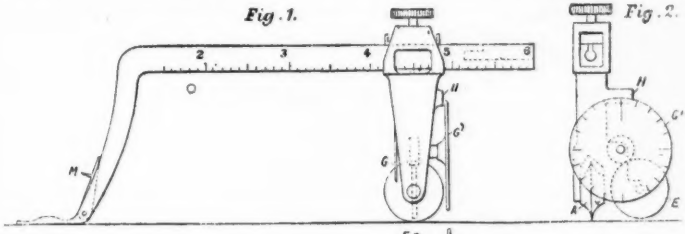


Fig. 2.

Fig. 3.

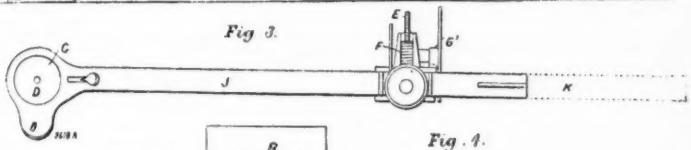


Fig. 4.

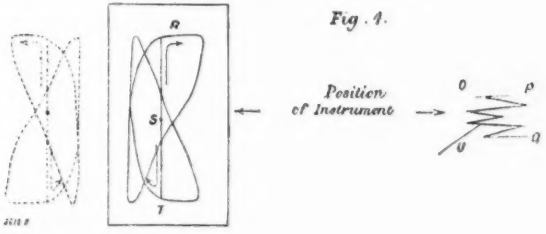
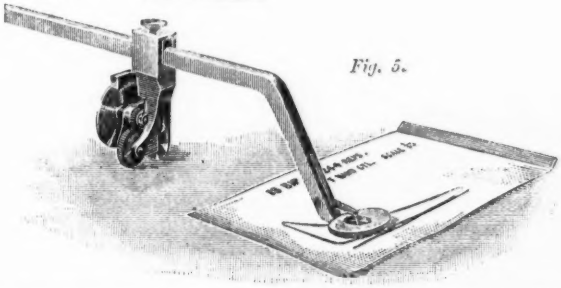


Fig. 5.



A, is moved along the stang, J, to double the length of the diagram, or 5½ inches. The diagram is placed on a piece of foolscap paper, and a line, R S T, is drawn from the boundary to the center of gravity, as near as can be judged by the eye (see Fig. 4). The instrument is placed at about a right angle with TR, with the tracing-point in the celluloid plate directly over the point, S. The sliding head is then lightly pressed by the left forefinger, in order to make a slight dent in the paper at P. The tracing-point is then carried along the line, S R, and around the boundary of the figure in the usual way, as indicated by the arrow (being the same direction as that in which the diagram is drawn by the indicator pencil), to S, the point of beginning. Then continue along the line to T, and go around the companion diagram till S is again reached, when another dent, Q, is made in the paper. If the center of gravity has been correctly taken, the distance, P Q, measured on the arc is the mean height of the diagram. In order to get rid of any error due to not having taken the center of gravity correctly, hold the instrument in position, and, after pressing the point, M, down through the hole, D (see Figs. 1 and 3), and the paper beneath, reverse the diagram as shown by the dotted lines. If now the tracing-point is caused to traverse the boundary in the direction of the dotted arrow, the final dent may be, say, at O; then the correct point will be midway between O and P. The furrow made by the knife edge wheel is of course imperceptible to the eye, but it is approximately of the shape shown at U.

To take the distance between the dents measured on the arc is not easy with an ordinary rule, such as must be used with the old form of hatchet planimeter; nor can the readings be made very accurately. In this improved planimeter this difficulty is surmounted by means of the small toothed wheels, E and F, and the recording disks, G and G' (Figs. 1, 2, and 3). The wheel, E, stands just clear of the paper while the tracing above described is performed and till the two dents in the paper have been made. Then the instrument is slightly tilted to bring the wheel, E, into contact with the paper, and, the knife-edge being then moved from one dent to the other, the wheel work is revolved, and the exact distance is read off at the zero point, H.

By means of lengthening bars, K, the instrument can be adapted to use for large areas, such as maps, and for surveyor's use. To find the area after once circumscribing the figure in the same direction, multiply the distance between the two dents by the distance at which the loose head is fixed on the stang, J; or, if the figure be twice circumscribed, by only half that distance.

The instrument is entirely self-contained, and it gives a direct reading on the recording disk.

It will stand rough usage, and may be conveniently carried in the pocket. By means of the lengthening bars the instrument will measure at a single reading any area likely to be required in every-day work. It is simple and not liable to get out of order, and is as accurate as the Amsler planimeter.

Captain H. Prytz has established the following equation.

$$A = T \times p \times \left\{ 1 - \left(\frac{R^2}{4\,p^2} \right) \right\}$$

Where

A=the area of the figure in square inches.

T=the distance between the dents in inches, or, where two readings are taken, it is the mean of the distances O Q and P Q. (See Fig. 4.)

p=the length in inches from the movable head to the tracing-point, as indicated on the graduated stang.

R^2=the mean square of the radii of the figure.

The correction is, therefore,

$$\frac{R^2}{4\,p^2} \cdot A.$$

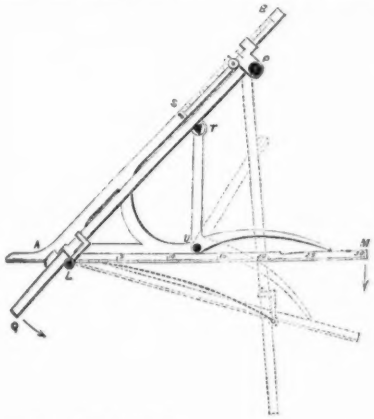
It is found that, for indicator diagrams, the quantity in the brackets is negligible. It is only in cases where the area is large when compared to the length of the instrument that this quantity affects the result. By the lengthening bars, it is easy to keep the length of the stang not less than twice the longest dimension of the area.

Very irregular figures would be best treated by being divided up and each part encircled separately, in accordance with the general practice in such cases. When, for example, the greatest extension of figure is half the length of the planimeter, then, R being less than ½ *p*, the correction $\frac{R^2}{4p^2}$. A is less than $\frac{1}{64}$ A.

The error may, however, be made still smaller by making the length of the stang three times the longest dimension of the figure, in which case it sinks altogether below the bounds of engineering calculations, and one takes the actual reading as with Amsler's planimeter.

The Monticolo Curve-Tracer.

THIS new instrument, designed to supersede the use of sweeps and scrolls heretofore used for drawing curves, is applicable to drawing circles or arcs of circles of larger radius than can be conveniently drawn with compasses or trammel; and it has the advantage, in the latter operation, that the center of the circle to be drawn



need not be located.

From *The Engineer* (Aug. 7) we have condensed the following description, reproducing the cut on a smaller scale. As usually made, the instrument commences with a radius of—11.8 in.; but the radius can be extended to any length in a straight line; that is, arcs of circles having radii ranging from 11.8 in. to infinity may be drawn. The instrument can be made to begin with a less radius, but smaller arcs would be generally described with compasses or trammel.

"In order to describe a curve with the instrument, the index of the slider, P, is placed opposite the point on the graduated scale, R S, which indicates the desired radius, S being the infinity end of the scale. The instrument is then arranged, as shown by the full lines in the figure, the moving arm, P Q, being parallel with and close up to the fixed arm, A R. The pencil or pen for tracing the curve is fixed in the holder, L, and is placed at the zero point of the scale on the arm, A M. The pencil or penholder is kept in close contact with the edge of the arm, A M, and, as it is moved to the right, it traces the curve shown by the thick dot and dash line in the figure. It will be noted that this curve has a chord as long as A M, —*viz.*, 30 centimeters, or 11.8 in.

"If it is desired to prolong the curve, draw a line along the right-hand edge of the bar, U T, and erect a perpendicular to it, which shall also be a tangent to the curve already drawn. Now, move the instrument until the zero point on A M coincides with the point where the tangent touches the curve, place A M in line with this tangent, and proceed to trace the curve as before.

"Of course the user may vary the radius of the second curve, if he so desires, and in this way also the different radii of any curving line may be read off, and an exact duplicate of the curve again laid down on another piece of paper, from these readings.

"The instrument is unique in that the curves drawn by it are rigorously arcs of circles, as may be shown by geometrical proof. There is, of course, the personal error of manipulation common to all mathematical apparatus; but, as the instrument is so very simple in construction, this is reduced to its lowest point."

Damascus Gun-Barrels.

THE making of barrels for sporting guns in the valley of the Vesdre, in the province of Liege, France, is a very interesting me-

chanical operation. These barrels are called "damascus," because the damascene appearance of the metal resembles that of the celebrated Damascus sword-blades, famous for their fine quality. The damascus gun-barrels herein described are made entirely by hand. The United States consul at Liege has described this manufacture in one of his reports, from which we make the following abstract.

The trade has descended through several generations.

The steel is imported from Westphalia; the iron is manufactured at Couvin; the coal for the numerous forges is obtained from the mines of the highlands of the Herve, situated in the vicinity of this industry, which furnish coal especially fitted for this work. The factories receive their motive power from the river Vesdre. The industry is said to be on the increase. Some years ago forges and workshops were entirely engaged in making iron barrels, and there were but few barrel-makers who produced tubes or barrels known as twist barrels, called by the French *canon tordu*, or *tors*, from *tordre*, to twist or contort. The ingot for the production of the curled damascus, which is the favorite design for fine guns, is composed of about thirty sheets of iron and steel, each having the thickness of four millimeters and a breadth of one hundred and twenty millimeters, which form a square mass about fifty centimeters long, and are enveloped in a box of common thin sheet iron or by small wires at each end. The package thus prepared is put into an oven and welded together at the lowest possible temperature. Too great a heat destroys the metal and yields a burned damascus, showing a small if any design. Each barrel receives one hundred and fifty welding heats while being forged, making three hundred heats for a double barrel. If one of these welding heats is unsuccessful, the barrel may be a failure, either by the alteration of the damascene appearance or by a trace of the smallest imperfection in welding. Swedish iron is not used in forming curled damascus—only refined charcoal iron of Belgium, which gives a greater contrasting hue to the steel, and can be welded at a lower heat. After the ingot is welded, it is rolled into small square rods of seven to nine millimeters, according to the design of the damascus desired.

The rods are then drawn into ribbons by the smiths. The manipulation of these ribbons at high temperature is such that in a length of one meter two hundred twists are shown. Coke iron will not answer for this fine work, for which charcoal iron is used exclusively, though an inferior quality of damascus can be made from coke iron. The twisting increases in pitch toward the thinner part of the barrel, which is first formed by winding the ribbons on a mandrel and welding the coils together at the edges. The barrels are then bored out, straightened, ground to the proper thickness, and polished. The joining of the barrels for double-barreled guns is a process requiring great care, as the value of the gun largely depends upon the accuracy with which this part of the process is executed. Each barrel is proved by a shooting test at the manufactory, before it is placed on sale. It is said that the annual production of these barrels is three hundred thousand; and that they are chiefly exported to England and the United States.

Oil in Boiler Scale.

THE following is an abstract of a note on the presence of oil in boiler scale read before the American Chemical Society by Charles A. Doremus. The facts stated indicate the importance of a more critical examination of the organic matter in analyses of boiler scale than is common, "loss of ignition" being far too general a statement.

The author first describes a sample of water obtained by melting the core of cakes of artificial ice. "The sediment is fine, flocculent, and of red color. When removed from the water and dried, it is pulverulent. There is very slight evidence of oil in the dry mass; the moist sediment does not appear oily. The large proportion of oil extracted by ether shows how inefficient the filters were in purifying the condensed steam. Yet very great pains were taken at the ice plant to secure

pure distilled water, and there was no visible oiliness in the water as it flowed to the freezing cans. Here, however, the corrosive action of the distilled water on the galvanized iron produced a mass of iron and zinc hydrates which, in being pushed to the center by the gradual formation of ice, gathered the oil and carried it to the core."

A specimen of water from a steamboat on the Hudson river using a surface condenser contained not only sea salt which had entered through leaks in the condenser, but also oil in a precipitate derived from it, this oil being dissolved out by ether.

In a specimen from a large plant in Chicago, evaporating 2,500 gallons of filtered river water and 25,000 of condensed water every twenty-four hours, and in which lubricating oil (mineral with ten per cent. animal) is freely used, the fine clay in the water, together with some incrusting ingredients, caused the oil to form into balls.

Two light-colored samples consisted of a fibrous incrustation composed of calcium carbonate and sulphate, intermingled with organic matter, partly oil.

"Another incrustation in thin sheets about three-sixteenths inch thick, of light slate color, is made up of alternating layers of deposits of varying hardness. The ingredients are again calcium carbonate and sulphate and clay, while there is much organic matter. This can be separated from the mineral in great part by a little acid. The presence of oil is then noticeable. The boiler of this plant is fed with Lake Michigan water and condenser water. The latter goes directly to the hot well of twenty-barrel capacity. While there are no oil filters, the boiler is provided with a skimmer, which draws off floating materials from just below the water line. The lubricating oil used is mineral with fifty per cent. animal.

"Notwithstanding the skimmer, the scale has formed and baked into a hard mass. It is highly non-conducting. It can be held by the fingers quite near to where a portion is heated in a Bunsen flame, the heat of which distils out and ignites the oil. A few pieces of this scale heated in an improvised retort made from a test-tube yield quite a gas flame. The presence of oil to the extent of from twenty to fifty per cent. in the deposits and scale of marine boilers filled with fresh water, any loss being made up from the exhaust or from sea-water, has been fully set forth by Lewes, who also gives the causes thereof and remedies therefor. He also alludes to the possibilities of this type of scale forming in stationary boilers."

The Early History of Rope Driving.

MR. ABRAM COMBE of Belfast, in a paper read before the Institution of Mechanical Engineers, having claimed that Mr. James Combe of Belfast was the first to use rope-driving, *The Electrical Review* (London, Aug. 14), while admitting it to be possible that Mr. Combe believes this assertion, says that, all the same, the allegation does not accord with the facts.

"The mule-spinning frame of Richard Roberts, of Manchester, patented in 1825 and improved in 1830, had the spindles driven by cords, and the rim band is to this day a feature in the spinning mule. Indeed, we believe that a rope was used in the spinning jenny of Hargreaves before Arkwright's time, and Arkwright patented his frame in 1769. We fear that there is no place for Mr. Combe's claim, so far as regards the use of ropes for driving purposes, for their origin dates back probably centuries, and the present writer has seen them on carding engines made before 1850. Mr. Combe, however, applied ropes to much larger powers.

"In 1863 he drove 200 h. p. by means of ropes, and he determined by experiment that the groove angle should be about 45°. The ropes were round, and made of leather, but there was a good deal of trouble experienced with them, and Manilla hemp was tried with better results. Mr. Combe's early proportions of pulley to rope diameter were from 28.8 : 1 to 36.0 : 1 for ropes of 1¼ to 2 inches diameter; and the all-round ratio of 30 : 1 is the modern ratio, and does not differ seriously from Mr. Combe's figures. As regards powers, he fixed on a speed of 100 revolutions as a basis, and allowed 5 i. h. p. for each 1¼-

rope on a 3-foot pulley, 8 i. h. p. for 1½-inch rope on 4-foot pulley, 11 i. h. p. for 1¾-inch rope on 5-foot pulley, and 15 i. h. p. for a 2-inch rope on a 6-foot pulley. These allowances may be increased 20 to 25 per cent. with safety under best conditions with long distance centers, or equally reduced for less favorable conditions.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

7599 Finishing Large Connecting Rods—De La Vergne Shops. John Randol (The description of method is illustrated by half-tone engravings). Am Mach–Aug 13. 2000 w.

7600. The Everlasting Mandrel Question—Expanding Boring Tools. C. O. Griffin (Illustrated description of a system of boring tools and some remarks on mandrels). Am Mach–Aug 13. 1000 w.

7726. Boring 48-Inch Fly-Wheels on a 20-Inch Lathe. C. O. Griffin (Illustrated description of means and method). Am Mach–Aug 20. 500 w.

7838. Laying Out Bicycle Sprockets. A. L. Bowen and F. H. Bullard (An important practical article, illustrated with diagrams, and showing that this mechanism can not be laid out analogously with the teeth of spur-gearing, with good results). Am Mach–Aug 27. 1600 w.

7868. Foundry Cranes. A. E. Outerbridge, Jr. (Read at meeting of Amer. Foundrymen's Assn. A very interesting paper illustrating and describing mechanism for handling heavy materials in foundries from early date to the present time). Foundry–Aug. 3200 w.

7869. Trolley Systems. F. O. Farwell (Illustrated description of a single rail trolley in a foundry with a switch thought to be as safe as any double track switch). Foundry–Aug. 700 w.

7927. Adjustable Bevel for Drawing. F. Spalding (Illustrated description of an instrument for mechanical and topographical drawing, and an explanation of its uses). Mach–Aug. 800 w.

*7944. Turned Foundry Patterns. Herbert Aughtie (Practical hints upon the making of this kind of patterns and the lathe-work involved in them). Prac Eng–Aug 21. 1000 w.

8054. Proportion of Gear Teeth. Samuel Webber (A criticism. The author considers that shearing strength instead of tensile strength should be the basis of formulæ and presents a formula accordingly). Mach, N. Y.–Sept. 1600 w.

8055. Strength of Gear Teeth. Charles L. Griffin (Diagram offered for the convenient use of the method of designing by the use of a factor of strength). Mach, N. Y.–Sept. 1000 w.

8105. Sub-Presses and Compound Dies. A. H. Cleaves (The utility of the sub-press is set forth and illustrated by examples and engravings). Am Mach–Sept. 10. 3300 w.

8106. Gas-Heating Machines (A variety of machines heating with gas fuel articles in process of manufacture, for hardening and tempering and for other purposes). Am Mach–Sept. 10. 1400 w.

Steam Engineering.

*7567. The Economy of the Modern Engine Room. Charles E. Emery (Discussing the problem of boiler selection). Eng Mag–Sept. Serial. 1st part. 5100 w.

†7614. Raworth's "Universal" High Speed Steam Engine (Illustrated detailed description of a design containing many novelties in construction). Ind & East Eng–Aug 1. 1800 w.

7710. The Economical Uses of Coal. John L. Howard (Read at meeting of Pacific Coast Gas Assn. Describes a method of promoting combustion by use of a steam jet of super-heated steam delivered through a peculiar nozzle in the ash-pit door, by which an increase in economy is claimed. Also discussion). Am Gas Lgt Jour–Aug 17. 5500 w.

7746. Value of Circulation in a Boiler. C. A. D. in *The Boiler Maker* (Effects of increase of circulation upon evaporation, increase of economy secured thereby, and different means that have been employed to increase rapidity of circulation). Ir Tr Rev–Aug 13. 2000 w.

7791. Efficiency of the Steam Engine (The author herein enunciates and discourses upon what he considers a rational basis for determination of real efficiency, from which he proceeds to a method for determining practical efficiency). Am Elect'n–Aug. 1400 w.

7799. The Steam Engine Indicator Card (Ideal indicator cards are the only ones considered. Diagrams illustrate the text). Am Elect'n–Aug. 1300 w.

7928. Selecting Boilers for Mills and Factories. W. H. Wakeman (A contribution to practical knowledge designed for the information of manufacturers and steam users). Mach–Aug. 2000 w.

7933. Another Vertical Cotton Mill Engine (Illustrated detailed description of a four-cylinder, triple-expansion engine of 2000 horse-power, to make 232 revolutions per minute). Power–Sept. 1500 w.

7936. Designing a Smoke Stack. A. G. Carlson (Smoke stack for a steam plant of 7680 horse-power. Defects in formulas). Power–Sept. 700 w.

*7942. Seam Rips and Hydraulic Tests (The advisability and value of the hydraulic test of boilers in all cases of inspection is editorially questioned. Especially for the detection of seam rips in egg-ended boilers it is considered worse than useless, though its value for determining tightness in new boilers, or in repairs of new boilers, is admitted). Prac Eng–Aug. 21. 1600 w.

We supply copies of these articles. See introductory.

8053. Setting a Slide Valve. F. F. Hemenway (The slide valve has been selected as the most common type, and thus better adapted to an exposition of the principles of valve setting in general). Mach, N. Y.-Sept. Serial. 1st part. 1400 w.

Miscellany.

7593. Trial of the Compressed Air Motor by the Third Avenue Railroad Company, New York (Description of motor, with cuts, and an account of some experiments). Sci Am-Aug. 15. 1000 w.

*7650. The Boydell Traction Engine (Illustrated detailed description). Eng, Lond-Aug. 7. 700 w.

*7658. Smoke Abatement (Editorial review of the report of an English committee for testing smoke-preventing appliances). Engng-Aug. 7. 1500 w.

7727. Flow of Compressed Air in Pipes. William Cox (An adaptation of D'Arcy's formula for flow of water in pipes, to make it applicable to any other fluid, is thought by the writer preferable for compressed air. The modified formula is presented and discussed). Am Mach-Aug. 20. 800 w.

*7742. The De Dion et Bouton Road Motor (Illustrated description). Engng-Aug. 14. Serial. 1st part. 3000 w.

*7745. An Improved Stang Planimeter. Ernest Kilburn Scott (Illustrated description). Engng-Aug. 14. 900 w.

7757. Cycle Mechanics. H. K. Landis (The statics and dynamics of cycle propulsion, weight, distribution, strength of parts, center of gravity, traction, work done, etc). Sci Am Sup-Aug. 22. 3300 w.

7802. A New Construction for Fly Wheel. A. P. Brayton and Edward S. Cobb (Illustrated description). Min & Sci Pr-Aug. 22. 1000 w.

7821. Standard Specifications for Structural Steel (Specifications adopted Aug. 9, with diagram showing shape and dimensions of standard test piece for sheared plates). Ir Age-Aug. 27. 1600 w.

7832. Machinery Bearings. John Dewrance (Illustrated description of experiments upon the frictional resistance of shafts under loads). Am Mach-Aug. 27. 2400 w.

7833. Flow of Compressed Air in Pipes. F. A. Halsey (A determination of the value of the constant in Cox's fluid flow computer, and a comparison of results with those obtained by D'Arcy's formula, showing that the computer is sufficiently accurate for most practical purposes). Am Mach-Aug. 27. 1000 w.

7834. Metric System (Discussion by members of the Engineers' Club of Philadelphia. A great diversity of views is manifested in the debate, but, on the whole, the weight of opinion seems against the passing of the bill relating to the compulsory adoption of the metric system). Am Mach-Aug. 27. 2500 w.

*7885. The Mechanic's Climacteric (Editorial. Notes the cause why mechanics approaching and passing the age of forty-five years, find increasing difficulty in finding steady employment). Engng-Aug. 21. 2200 w.

*7887. Goodman's Hatchet Planimeters (An improved form by Prof. Goodman of Leeds, Eng., is illustrated and described). Engng-Aug. 21. 2000 w.

7935. Refrigeration for Engineers. Otto Luhr (A plain dissertation upon the philosophy of refrigeration). Power-Sept. 1200 w.

†7967. The Relations of Electricity to Steam and Water-Power. Charles E. Emery (A consideration of cost as dependent upon special local conditions which are stated, illustrated by examples of actual installations). Jour Fr Inst-Sept. 8000 w.

7971. Solid and Hollow Shafts and Their Weight Relation. Henry Hese (Formula for solid shafts and diagrammatic method of finding hollow shafts after the solid shaft has been calculated). Am Mach-Sept. 3. 600 w.

†7990. The Peaucellier Link Work. A. Ewbank (A detailed study of this device for obtaining rectilinear motion from rotary motion). Ind Engng-July 25. 1800 w.

7991. The "Inventive" Faculty. W. H. Smyth (A reply to criticisms upon two articles, to wit, "Is the Inventive Faculty a Myth?" *Engineering Magazine*, Aug., '95, and "Invention the Indefinable Requirement of the Patent Law," *Mining and Scientific Press*, May 4th and 11th, '96. First part replies to a review, in the *Engineering Magazine*, of the second article named). Min & Sci Pr-Aug. 1. 1500 w.

8049. The Watertown Arsenal (Illustrated description, historical and general, of foundry shops, tools, appliances and arms manufactured). Mach, N. Y.-Sept. Serial. 1st part. 2500 w.

8050. A New Power Laboratory. Sidney A. Reeve (Illustrated description of two new laboratory buildings and their outfits, for the department of mechanical engineering of the Worcester Polytechnic Institute). Mach, N. Y. -Sept. 1000 w.

8051. The Wide Belt Heresy. W. L. Cheney (The belief that a wide belt on a wide pulley exerts greater friction than a narrow one, other things being equal, is the "heresy" herein combatted). Mach, N. Y.-Sept. 1000 w.

8052. The Original Corliss Pumping Engine. Lester G. French (Illustrated description). Mach, N. Y.-Sept. 1000 w.

8067. Engineering at Purdue University (Illustrated description). Ry Mas Mech-Sept. 2000 w.

*8101. Thwaites Motor Car Producers (Account of a series of tests with a Thwaites' "simplex" and a "duplex" gas producer. Numerous diagrams and voluminous data). Eng, Lond-Aug. 28. 5500 w.

8108. A Remarkable Clock. W. F. Durfee (Illustrated description of a clock operated by variations in atmospheric pressure). Am Mach-Sept. 10. 2400 w.

8114. Retinning. D. E. Ibbott in *Ironmongery* (Practical suggestions addressed to those who have already a preliminary knowledge of the subject). Ir Age-Sept. 10. 1600 w.

MINING & METALLURGY

The World's Production of Gold.

WE hear a good deal, in these days, of the insufficiency of the world's production of gold for supplying an adequate volume of currency. The political orator is fond of representing gold-mining as an insignificant industry, controlled by an aristocratic monopoly, which, in the first place, by means partly occult and partly evident, in "collusion with Lombard street and Wall street," has controlled the legislation of the civilized world, so as to appreciate the value of its hoardings (for, according to these modern new-school economists' value is solely a matter of legislation), and, in the second place, is favored by conditions of supply and demand (so far as these are allowed any force in the new philosophy) in the "fact" that the supply is absurdly insufficient.

Indeed, one might easily conclude that there was no addition being made to the world's supply of gold, but that this was actually decreasing, no doubt being directly consumed by the hated gold-hoarders, who thrive on idle stores locked in their vaults.

It must be most annoying to have the statistician upset this line of fallacy by an abominable array of figures, but the statistician is a pestiferous person not easily silenced. He insists upon promulgating his unanswerable figures, showing that gold production is not only continuing, but vastly increasing, probably at a ratio far greater than proportionate. The situation is thus summed up by *Popular Science:*

"It is now evident that the production of gold for the next fifty years will be altogether unprecedented. This production has been vigorously stimulated by fresh discoveries of mines, by new and cheap mining processes, and by the fall of silver, leading miners to pay greater attention to the other metal. The operation of the latter factor is best seen in Colorado, where the production of gold rose from $5,300,000 in 1892 to $7,527,000 in 1893, and to about $12,000,000 in 1894. The production of 1895 in Colorado is confidently expected to reach $20,000,000. The director of the mint is of the opinion that the production of the United States rose from $33,014,981 in 1892 to about $39,500,000 in 1894, while other good authorities put the production of 1894 at $50,000,000. The annual report of other great producing countries shows a large increase of late years. In his notable article in the *North American Review*, Mr. Preston states that the world's production of gold for 1893 was 'the largest in history, amounting in round numbers to $155,522,000.' The product of 1864, however, very largely exceeded—probably by twenty-five per cent.—the product of 1893. There is scarcely any assignable limit to the gold known to exist in the world, or even in the United States. It is said that simply by the removal of the restrictions on hydraulic mining California can produce half a billion of gold. The quantity easily obtainable in Colorado is stupendous. Other parts of the United States are also rich, while Australia and Russia probably possess a stock equal to our own and are increasing the annual output every year.

"But the most surprising, and, so to speak, revolutionary facts regarding gold that have recently come to light are those concerning the great Witwatersrandt mines of South Africa. There the gold is found in enormous quantities and in a cheaply workable form in a new geological situation—'in strata the component parts of which are are pieces of quartz held together by a clayey cement.'"

It seems probable, however, that the newer Australian developments may prove even more "surprising and revolutionary," from the point of view of production at least, if not of geologic occurrence.

Two or three propositions are suggested by these premises. One is that the production seems likely to be quite large enough to afford a basis for settling the trade-balances of the world; another is that gold, after all, is like other commodities, and subject to the same influences

from increased supply and decreased cost of production; a third is that, measured by the great final standard of labor-cost, gold is not appreciating, but depreciating, in value.

Crystalline Fracture of Iron and Steel.

THE paper by W. F. Durfee on "The Conditions Which Cause Iron and Steel Low in Carbon to be Crystalline," published in the *Journal of the Franklin Institute*, is an important contribution to the literature of a vexed subject, and, although already extensively noticed, will no doubt excite a still wider attention.

By a carefully-prepared table of characteristic chemical compositions, compiled from unquestioned authorities, Mr. Durfee dismisses "the opinion, common among users of wrought iron and soft steel, that the former has no carbon associated with it, and the belief, also prevalent, that the minute percentage of carbon (0.10 to 0.15 of 1 per cent.) in the latter is at once the cause and explanation of the structural dissimilarity of these metals."

He shows "that Lowmoor iron boiler plate has more carbon than extra soft Fagersta steel," Staffordshire boiler plate twice as much, some samples of Russian and Swedish bar iron over four times as much, and a sample of wrought iron made by the Catalan process five times as much.

What, then, is steel as distinguished from iron? Mr. Durfee says:

"To the many answers to this frequently-asked question I will venture to add one more,—*viz.*, steel is iron freed from mechanically-mixed impurities (such as 'cinder,' etc.), by a melting process, during which there is combined with it chemically a small percentage (not large enough to prevent the metal being forged or rolled) of other impurities, introduced for the purpose of modifying its strength, hardness, elasticity, or ductility, in such way and degree as to adapt it to the particular use to which it is to be applied. In short, while wrought iron is iron having (as the unavoidable result of the methods employed in its manufacture) its impurities mechanically mixed therewith, steel is iron having (as the result of the adoption of appropriate manufacturing processes) its impurities chemically combined therewith."

Following out the consideration of the structural peculiarities of wrought iron under this conception, he finds that, "when a properly-heated 'bloom,' or other similarly-constituted mass of wrought iron, is subjected to the action of the hammer or rolls, the contained 'cinder' endeavors to escape from its entangled mechanical alliance with the crystals of the iron, and, in so doing, each particle thereof is driven into some line of least resistance, which is always finally located in a plane at right angles to the direction of the force acting upon the metal. In other words, if the bloom is rolled or forged into a rod or bar, the metal will be acted upon in two directions at right angles to each other, and its compound crystals will be compressed in directions normal to the exterior surfaces of the bar, and at the same time extended in the direction of its length."

"The direct consequence of the elongation of its compound crystals, and the effort of the intervening 'cinder' to escape in the direction of least resistance . . . is the establishment of that structural peculiarity in the resulting bar known as 'fiber.'"

"But let us return to our question. Can a bar of wrought iron of a pronounced fibrous structure be ruptured so as to exhibit a crystalline fracture? I answer, yes—in two ways:

"(1) By a sudden application of a force of extension, commonly called a 'jerk.'

"(2) By a prolonged repetition of a force of compression, sometimes called a 'jar.'"

But this unusual form of fracture Mr. Durfee proceeds to trace to the normal mechanical effect of the treatment upon a compound internal structure, such as he conceives to exist in the iron, and not, as often conjectured, to any molecular or chemical changes in the "crystals" of the iron.

Passing now to steel, he finds that "all steel in our day (save the comparatively

unimportant product called blister steel) is made by some process involving melting and casting; and, although the various methods employed all practically free the metal from an admixture of 'cinder,' and in consequence tend, so far as the elimination of cinder is concerned, to produce a homogeneous crystalline structure, still, owing to defects inherent in the method of casting,—and oftentimes in the chemical constitution of the metal itself,—the ingots of steel are too often far from homogeneous. In fact, their structure may be such that, when hammered or rolled, the resulting bar, although destitute of 'cinder,' may, nevertheless, show evidences of 'fiber.'"

This, he thinks, is due to a separation of the crystals one from another, somewhat as in the case of iron, but by a different agency,—*i. e.*, by a multitude of minute cavities. The presence of these cavities, though generally recognized, is usually attributed to some chemical reaction set up in the manufacture or casting of the steel.

Mr. Durfee's "explanation of the formation and distribution of these cavities is a purely mechanical one."

"It is a well-known fact that a vertical stream of any liquid descending freely through the atmosphere drags along with it, by frictional contact, a notable quantity of the air, or of any other gas that may be in its immediate vicinity."

He shows that this tendency increases with the viscosity of the liquid, and would be most marked with such a fluid as molten steel. He discusses very ably the result of the tendency, and the range of effect, under varying treatment, upon the physical properties of the manufactured metal. To the lack of homogeneity thus induced he attributes many of the obscure or unexplained defects observed in steel castings and forgings, but lack of space forbids anything but the indication of his line of treatment. He does not fail, however, to offer, in conclusion, a practical suggestion for improvement.

"After thus discussing the defects of the ordinary method of manufacturing steel, I may be asked how to overcome them.

"I answer, not by removing them, but by preventing the development of their causes,—'blow-holes' and internal ruptures. The first can be prevented by casting the steel in a vacuum,—that is to say, by exhausting the interior of the ingot mold and allowing the stream of molten steel to fall into it, without the possibility of its dragging air along with it. The second can only be avoided by careful heating of ingots which contain no gas-filled blow-holes.

"Eternal vigilance is the price of excellence!"

The Origin of Anthracite.

A HIGHLY interesting contribution to the literature of anthracite is made by Mr. W. S. Gresley, in a paper contributed to the *American Geologist* which has attracted considerable attention and been widely copied, notably by *The Colliery Guardian* (London), which reproduces the article in full.

It is, unfortunately, too long to be presented here, except in brief summary. It is called out by Mr. Gresley's strong dissent from a theory recently advanced by Dr. J. J. Stevenson, who, criticising all leading theories as to the origin of Pennsylvania anthracite and finding them wanting, advances a novel one of his own.

"He considers that the anthracite of Pennsylvania was originally vegetable matter similar to that of which the bituminous seams of the western part of that State are formed, but that the coal is not now bituminous because the accumulation of vegetable matter in the eastern area remained exposed for a longer period to the agencies which formed coal (before being covered up with sediment) than those of the western area."

So that, to quote Mr. Gresley, "the inference is that Stevenson does not consider the partial metamorphism to which the anthracite series of coal measures have, as a whole, unquestionably been subjected has been instrumental in converting the once bituminous coal into semi-anthracites and hard dry anthracites."

Mr. Gresley, on the other hand, as becomes increasingly apparent with the pro-

gress of his argument, is inclined to find in metamorphism not only a contributing, but almost the sole, agency in "anthracitification" of the early coal-beds.

To establish the position, he proceeds first to demonstrate the fact of evident metamorphism in the coal measures generally. The evidence, which appears to him satisfactory, is that the fireclays, shales, sandstones, and grits of these regions are more compact, tougher, heavier, and more weather-resisting than those of the bituminous region; that the conglomerates, composed chiefly of quartz pebbles, are extremely compact and dense, and occasionally adjacent pebbles have been partially deformed, or squeezed into one another without fracture, while some quartz veins are noted, running through the conglomerate and passing through the pebbles, which show a fused appearance where incorporated in the veins; that the clay iron stone nodules are very dense and hard, and show distinct zones of mineralization, and contain crystalline pyrite; that the fossils show a peculiar blacklead color and greasy luster observed in those of the States of Rhode Island and Massachusetts and of the Alps; that the coals are very hard, compact, glassy, and remarkable for the quantities of occluded gas existing in them, considering the apparent freedom from interstices or cellular structure; that there is carbon impregnation with streaks of graphite, and a more or less diffused blackening throughout the series; and that "fine crystals of amethystine quartz have been found near Pittston, masses of lead and zinc ores in fissures in the coal-beds near Scranton, smoky and clear quartz crystals near Tamaqua, and very hard and brilliantly crystallized pyrite has been extensively found near Pittston."

Altogether, the anthracite measures "are of greater specific gravity, more crystalline, more siliceous, tougher, harder, and darker than those of the western coalfield of Pennsylvania."

On the other hand, the objections to Dr. Stevenson's explanation are that, "in order to agree with this theory, facts ought to show that the percentage of volatiles in the anthracite decreases with the depth of the seam,—*i. e.*, the lowest bench of coal of any typical seam, other things being equal, ought to be lower in volatile matter and higher in fixed carbon than the uppermost bench; or that there is an apparent gradation in chemical composition from top to bottom of the seam, debituminization having gone on longest and been strongest in the lowest layers. But published analyses do not reveal any such change that may be regarded as of any value in this connection."

Again:

"We may take it for granted that, when a carbonaceous shale enclosing numerous fish remains, shells, etc., forms the uppermost layer of a bed of coal, as is very commonly the case, the inference is that the coal deposit was not suddenly and completely buried beneath sediments on the completion of the vegetable matter accumulation; otherwise no time or conditions would be allowed for the fauna to get there and occupy the waters for long periods, as they evidently did, before the invasions of mud or sand followed. No fish beds have been discovered or reported atop of any of the Pennsylvania anthracite seams. And they seem to be just what Stevenson's theory would call for, if his deferred burial of the coal material actually obtained in that portion of the Pennsylvania coalfield. And, when we get typical bituminous coal capped by fish beds, we almost possess just the conditions of deposition which Stevenson would apply to the anthracite region, but scarcely look for in the non-anthracite areas; so that, if the occurrence of fish beds is any index of delayed oncoming mud or sand deposits, then, on Stevenson's theory, the bituminous coal ought now to be anthracite and the now anthracite bituminous." Mr. Gresley's own theory is that the "anthracite had a metamorphic origin, but is not a product of folding."

"As any stage in debituminization of a coal-bed is to some extent metamorphism, the stage we designate anthracite is a stage in the metamorphic process. Graphite is probably metamorphosed anthracite, just as anthracite is metamorphosed bitumi-

nous coal, or bituminous coal is metamorphosed lignite.

"The origin of the anthracite of Pennsylvania was certainly a metamorphic one, and not due or confined only to the certain horizons,—beds of coal,—as Stevenson seems to suggest. The writer does not agree with those who suppose that the metamorphism apparent in the eastern Allegheny coal-fields was principally a result of the folding, crushing, thrust pressures, and of fissuring, which aided the escape of the volatiles of the coal; but he would venture to submit what he will call the hot water or hydrothermal theory, as possibly the most rational one yet advanced, or the one to which all the observed facts or phenomena of the region in Pennsylvania (and certain others beside) fit best."

This theory, as Mr. Gresley develops it, is very briefly, as follows. The existing anthracite measures are remnants of a vast coal-field, and owe their escape from complete destruction by denudation solely to their "synclinal or pockety forms."

The coal-making strata were deposited by and in water, and the fact that the alternating strata are sandstones, grits, and conglomerates rather than slates and shales indicates proximity to a shore line undergoing rapid denudation. The coarser materials would be laid down first, and the finer mud in deeper water.

The rapid deposit of coarse material implies a rapidly-increasing weight of surface strata, which gradually forced the deeper layers, still saturated with water, downward within reach of the influence of the earth's internal heat. At some time—probably in the permian—stratum-building ceased. The action of the interior heat on the water-soaked lower strata caused chemical changes, including "debituminization," accompanied by softening and swelling of the whole layer; softening means weakening, and the swelling forced the weakened strata in the only direction in which they were free to move—that is, upward.

"Accompanying this upswelling of the rocks would be subaërial denudation, and, in conjunction with the assumed lateral thrust given to the mass of rocks by the bordering and perhaps now subsiding land, it seems proper to suppose that severe folding and rapid elevation into mountains would take place. Once the region began to rise, weakness would induce plication; plication and elevation would produce shrinkage, cracking, cooling; and extensive wearing away would accompany these processes. It is highly probable that mountain-forming or the elevating process would go on much faster than removal by denudation or erosion. In the case of the Pennsylvania anthracite region it is supposed that the side pressure on the uprising coal measures, etc., was most severe or operated mainly from the east, thus creating anticlines which have their steeper slopes facing the west, as is found to be the case. The cooling-off of the strata and the deep-seated or elevating pressures combined would produce the jointing, fissuring, and all the observed slip cleavage in the coal, etc. Such, then, is about the best or briefest description the author can give of the successive geologic events to which the anthracite in Pennsylvania is probably mainly due, and upon which we would look back as having brought this splendid fuel within our reach; for, had the coal measures remained down there in plutonic regions, where the anthraciting process went on, the probabilities are man would have been unable to reach it. This coal then, I claim, is essentially a product of the origin, cause, and process of mountain-making,—*i. e.*, internal heat acting upon water-soaked strata of vegetable matter and inorganic sediments, depressed far enough below the surface (prior to a necessary upheaval) to put the rocks through a process of 'cooking;' which process, of course, operated more or less according to depth, kind, and amount of water, the variable character of the individual beds, and local influences."

This "working hypothesis" is fortified by adducing evidences of hydrothermal action in the region—such as hot springs—and of artificial formation of anthracite from wood, by the action of hot water under extreme pressure, as in the timbering of burned and flooded mines.

It is certainly striking; but it seems to dissociate the origin of the mountains of the coal region from the great Appalachian uplift to which they are generally referred, but which, as a whole, could hardly have been caused by the agency suggested by Mr. Gresley.

Discoveries of Mercury in South Africa.

A NEW and apparently important discovery of "cinnabar and mercury bearing alluvial has been made near Johannesburg," says the *Australian Mining Standard*, where "many efforts have been made to discover mercury, previously without success."

The discovery is spoken of as doubtless having great interest for all mine-managers; probably this will be so, although the very extensive use of the cyanid process reported from South Africa must somewhat diminish the importance of mercury.

The deposit reported is remarkable in some respects, and further development will be awaited with interest. The *Standard's* statements as to the richness of the vein of ore are not quite clear, but it appears that concentrates were secured assaying "65.40 per cent." mercury.

So far as yet developed, "the property consists of three hundred claims—about five hundred English acres—with three miles along the formation. It is situated on government ground in the De Kaap goldfields, near the junction of the Umsluimiaiti and Lomatic rivers, and is about twenty miles south of the Pretoria-Delagoa bay railway, to which there is good access. The formation in which the cinnabar occurs is sedimentary, consisting of chloratic and talco-chloratic schists, sandstone, and quartz. On the out-crop the formation has been tilted to almost a vertical position, but in depth they dip to the south. The strike of the formation is east to west, dipping south. The cinnabar occurs particularly on the contact of the talco schists and sandstone mixed with quartz, in veins and veinlets and impregnations. The out-crop now worked extends over 600 yards, and with visible cinnabar; several shafts opened into the out-crop are 10 to 15 feet in depth, a tunnel and cut for formation at 35 feet depth, and 128 feet of driving into the formation. From these several workings about 25 tons of ore have been extracted, of which the samples—several hundred pounds in weight—contain cinnabar with over 10 per cent. of mercury; but many of the samples are much richer. In cutting the alluvial soil for opening the tunnel it has been discovered that such soil is thoroughly impregnated with metallic mercury, and a few openings of this soil gave several ounces of mercury, and, should the same average continue, many thousands of tons of this soil are available. Many very pretty crystals of cinnabar were found. The peculiar nature of the rock admits of a very easy and economical treatment for the reduction of the cinnabar into mercury. The property has easy access to the railway, and a large amount of trees for building, timber, and fuel are on the spot; a large river traverses the property, and will be used for obtaining the motive power."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

7580. Molecular Annealing of Cast Iron (Reviews interesting points in a recent paper by A. E. Outerbridge, and calling attention to the difference of conditions existing in cast iron bars which have been molecularly annealed, when turned or machined for tensile tests, and similar bars tested in "the rough" for transverse strength). Ir Tr Rev–Aug. 6. 1800 w.

*7651. American Plate Trials (Description of the trials, with half-tone illustrations showing condition of the plates and of the projectiles after impact). Eng, Lond–Aug. 7. 1400 w.

*7653. The Walrand-Legenisel Steel-Casting Process. H. L. Hollis (Gives some details of the process, which is practically an addition to the Bessemer process, giving quiet and more fluid steel, and furnishes information regarding physical properties of the metal obtained. From a paper read before the Am. Inst. of Min. Engs). Col Guard–Aug. 7. 1700 w.

7670. Iron Making in Alabama. William B.

We supply copies of these articles. See introductory.

Phillips (Extract from the 1896 report of the Alabama Geological Survey. Historical review of the past 25 years). Am Mfr & Ir Wld–Aug. 14. 1800 w.

7671. Blast Furnaces Aug. 1, 1896 (A tabular statement of number, condition, fuel and output). Am Mfr & Ir Wld–Aug. 14.

7673 Treatment of Quicksilver Ores in the Asturias, Spain. From *The Mineral Industry, Vol. IV.* (Describes, with illustrations, the several types of furnaces employed and the method of operating each). Eng & Min Jour–Aug. 15. 3000 w.

*7685. The Iron and Steel Works of the North of Spain (Particulars of the Vizcaya Company's plant at Bilbao). Ir & Coal Trds Rev–Aug. 14. 2200 w.

*7687. A Study of Some Alloys with Iron Carbides; Mainly Manganese and Tungsten. J. S. de Benneville (Paper read before the Iron and Steel Inst. Giving results of experiments upon the structure of iron alloys by a purely analytical method). Ir & Coal Trds Rev–Aug. 14. Serial. 1st part. 4500 w.

7749. Dauber's Gas Blast Furnace (Illustrated description). Am Mfr & Ir Wld–Aug. 21. 350 w.

7774. Treating Tailings by Cyanide (Describes the adaptation of the process to the special difficulties met with in the treatment of tailings). W Min Wld–Aug. 15. 1100 w.

7808. Retort Coking. John S. Kennedy The utilization and the value of the by-products. Different systems of retort coking are also discussed). Tradesman–Aug. 15. 2000 w.

7820. The Wellman Charging Machine (Illustrated description of machine for charging open hearth furnaces). Ir Age–Aug. 27. 900 w.

7827. An Opportunity for An American Steel Rail Plant in Australia (The opportunity here discussed is suggested by the proposals advertised for, by the Secretary of Public Works, at Sidney, for 150,000 tons of steel rails and other track materials). Eng News–Aug. 27. 2000 w.

7893. The Gold-Arsenic Works at Bovisa, Italy. F. Clerici (Describes the ore, plant, and method of treatment). Eng & Min Jour–Aug. 29. 1000 w.

7945. Coal Dust Firing in the Iron Industry. Victor von Neumann (Conclusion of a paper read before the Inst. of Austrian Engs. and Arch'ts. The advantages are said to be a saving in coal, a saving in labor, and absolute freedom from smoke). Am Mfr & Ir Wld–Aug. 28. 1500 w.

†7968. Some Recent Work on Molecular Physics. Reginald A. Fessenden (The behavior of metals which are in every day use, and an attempt to explain this behavior by certain theories, original with the author. Illustrated by numerous diagrams). Jour Fr Inst–Sept. 10000 w.

7984. Modern Methods of Iron Mining and Smelting. William P. Kibbee (Brief account of the chief grades of iron ores, with methods of treatment, etc). Sci Am Sup–Sept. 5. 1500 w.

*7987. Wrought and Cast Ironwork (Historical illustrated description). Ill Car & Build–Aug. 21. 3800 w.

7988. Iron and Steel Works of the United States. From the *Directory of Iron and Steel Works* (Information respecting the development and present number of works and manufacturing plants). Am Arch–Aug. 29. 1200 w.

†7993. An Iodometric Method for the Determination of Phosphorous in Iron. Charlotte Fairbanks (Describes experiments and gives table showing satisfactory results). Am Jour of Sci–Sept. 1500 w.

*8001. The Iron and Steel Industries of Scotland (Illustrated description of the Carron Ironworks, the oldest in Scotland). Ir & Coal Tr Rev–Aug. 21. 3000 w.

*8002. Vanadium Steel. Otto Vogel, in *Stahl und Eisen* (Brief statement of the three methods by which basic steel was treated, in the experiments made M. K. Hélouis). Ir & Coal Trade Rev–Aug. 21. 500 w.

*8003. The Coal and Iron Resources of Spain, with Notices of the Principal Works (The first part consists of historical notes, and account of the coal and iron resources of the north of Spain). Ir & Coal Trade Rev–Aug. 21. 4000 w.

*8008. Note "On the Causes of the Loss of Sulphur in Estimating it by Evolution Methods in Iron and Steel." E. S. Rhead (From the Journal of the West of Scotland Iron and Steel Institute. A corroboration of the results arrived at by Mr. F. C. Phillips). Ind & Ir–Aug. 21. 700 w.

†8021. Aluminum Analysis. James Otis Handy (The method is described with apparatus used, and analysis given. Special methods are also given for determinations other than silicon, copper and iron). Jour Am Chem Soc–Sept. 6000 w.

†8023. The Actual Accuracy of Chemical Analysis. Frederic P. Dewey (The consideration of the subject is confined to analysis of metals,—determinations of marganese in steel, and phosphorous in pig iron. Analyses of copper, gold and silver are also discussed). Jour Am Chem Soc–Sept. 3500 w.

*8091. The Glengarnock Iron and Steel Works (Illustrated description). Ir & Coal Trd Rev–Aug. 28. 3000 w.

*8097. Coke Making (Historical account, with a study of the economical problems connected with the industry). Eng, Lond–Aug. 28. Serial. 1st part. 4500 w.

Mining.

*7566. The Less-Known Gold Fields of Colorado. Ill. Thomas Tonge (A visitor's observations of the resources of the gold belt of Gunnison county). Eng Mag–Sept. 3500 w.

*7639. Transmission of Power in Mines. Rankin Kennedy (The three systems of steam, compressed air, and electricity are compared in this first paper, and special conditions favoring one or another of the systems are pointed out). Elec Rev, Lond–Aug. 7. Serial. 1st part. 2500 w.

We supply copies of these articles. See introductory.

*7655. The Coolgardie Gold Fields. Victor Hansard Yockney (The first number is devoted to a general description of the country and the condition of transportation and living). Min Jour–Aug. 8. Serial. 1st part. 2000 w.

7675. Wolfram Ore. R. Helmhacker (Describes the occurrence, mining, and treatment of the ore in the Erzgebirge). Eng & Min Jour–Aug. 15. 1800 w.

7696. Ore Hoisting and Conveying Machinery at Ashtabula, Ohio (Illustrated description). Eng News–Aug. 20. 800 w.

*7730. Copper Ores in the Permian of Texas. E. J. Schmitz (Paper read before the Am. Inst. of Min. Engs. Discusses the occurrence, and refers it to somewhat similar agencies as those producing the Kupferschiefer of Germany). Min Jour–Aug. 15. 2000 w.

*7731. Coaldust: An Addition to the Priority Question. James Ashworth (Coaldust and explosives and the influence of coaldust upon the safety lamps are discussed). Col Guard–Aug. 14. 1300 w.

*7732. The Problem of Safe Blasting. H. W. Halbaum (Review of the report of the North of England Inst. Flameless Explosives Committee. The report is severely criticised). Col Guard–Aug. 14. 2200 w.

*7733. Firedamp Testing Station at Marchienne-au-Pont. H. Schmerber (Illustrated description). Col Guard–Aug. 14. 900 w.

*7734. Economical Results of Working Thin Seams (From a communication to the Société de l'Industrie Minérale on the working of thin seams in the Franco-Belgian coalfield, by M. F. Cambessédés, professor of Mine Working at the Douai School of Master Miners. Influence of methods of working upon economical results). Col Guard–Aug. 14. 1400 w.

*7739. Wedges and Explosives in Mines (Utility of Elliot's compound wedge). Eng, Lond–Aug. 14 800 w.

*7763. The Leith Mine. H. L. Auchmuty (A description of a modern mine and coke works in the Connellsville region. The geological features of the tract worked, the system of mining employed, and the method of timbering, ventilating and drainage, together with a description of the surface improvements). Col Eng–Aug. Serial. 1st part. 6500 w.

*7764. Robbing Pillars (Correction of popular error as to meaning of expression and very clear explanation of coal mining methods). Col Eng–Aug. 800 w.

*7765. Iron Ore Mining in Michigan (A review of conditions based on report of the Commissioner of mineral statistics). Col Eng–Aug. 1000 w.

*7766. The Twin Shaft Disaster (Description of the mine, its geological features, and the method of mining employed). Col Eng–Aug. 3300 w.

*7767. Plumbing Shafts. George B. Hadesty (A reliable and simple method for carrying a meridian into a mine. Describes a four-wire method, said to be speedy and reliable). Col Eng–Aug. 1500 w.

*7768. Hoisting Machinery. Charles S. Herzig (The methods of hoisting employed at Butte, Mont. An exposition of the inapplicability of the Koepe system to the conditions at Butte). Col Eng–Aug. 2800 w.

*7769. Coal Dust Explosions. John Verner (Argues, as necessary accompaniments of the blown out shot, intense heat and considerable flame, a rapidly moving current of pure air, and coal dust of special fineness and composition floating in the air). Col Eng–Aug. 2800 w.

7778. British Columbia Mines. H. M. Beadle (A general descriptive account). Eng & Min Jour–Aug. 22. 2000 w.

7779. The Gold Industry of British Guiana. David E. Headley (Historical and descriptive sketch). Eng & Min Jour–Aug. 22. 3800 w.

7809. New Soddy Coal Co.'s Coal Washing Plant (Illustrated description). Tradesman–Aug. 15. 700 w.

†7867. On the Occurrence of Galena at Smithfield, N. S. John E. Hardman (Gives what is said to be the first correct account, and suggests the possibility of future development, proving the deposits to be of economic value). Jour of Can Min Inst–Vol I, Pt I. 1800 w.

†7875. Arrangement of Coal Washing Plant for Treating Bituminous Coals. Edgar G. Tuttle (Description, specifications and drawings for a plant capable of handling 300 tons per diem). Sch of Mines Jour–July. 9000 w.

7891. Mining in the Mojave Desert in California F. M. Endlich (Descriptive account of a new gold region). Eng & Min Jour–Aug. 29. 1500 w.

7926. More Gold from South Africa (Indications of new prosperity and expansion in the South African goldfields). Bradstreet's–Aug. 29. 600 w.

*7951. The Leading Gold Mine of Tasmania (A descriptive account of the Tasmania Mine, Beaconsfield). Aust Min Stand–July 23. 4500 w.

*7952. An Auriferous Mountain (Description of an extraordinary discovery in the Gippsland district, near Melbourne). Aust Min Stand–July 23. 1100 w.

*7963. Improvements in Blasting Operations in Collieries. M. C. Ihlseng (A review of the conditions present, and the best practice in view of these conditions). Can Min Rev–Aug. 3300 w.

*7964. Wire Ropes (Practical points for the consideration of engineers and mining students. A collection of papers from the Transactions of the British Society of Mining Students). Can Min Rev–Aug. 3000 w.

7965. State Work in Mining Interests (Favorable comment on the work of geological surveys, and argument for the extension of the interests of mining). Min & Sci Pr–Aug. 29. 900 w.

*8009. Phœnician Mining. A. Cooper Key (From a paper on "Ancient Mining," read before the Inst. of Mining and Metallurgy. The journeyings of the Phœnicians in seeking riches, as few metals were found in their country). Col Guard–Aug. 21. 1800 w.

*8010. Working the Highly-Inclined and Reversed Portions of a Thin Seam at the Escarpelle Colliery. M. F. Cambessédès (From a communication to the Société de l'Industrie Minérale, Saint-Etienne. Details of the method of working). Col Guard–Aug. 21. 1200 w.

*8011. Malay Gold Mining (The extent to which the industry has been carried on under European and Australian auspices). Min Jour–Aug. 22. 900 w.

*8012. The Origin of Placer Gold (What placer gold really is, with a sketch of the more modern views of the mode of the deposits). Min Jour–Aug. 22. Serial. 1st part. 2000 w.

8031. The Great Hoisting Engines for the Anaconda Mining Co. (Illustrated description). Eng News–Sept. 3. 800 w.

8048. The Valuation of Iron Ore. G. Teichgraber (From *Stahl und Eisen*. Showing what determines the cost of pig iron). Am Mfr & Ir Wld–Sept. 4. 800 w.

*8077. Silver Mining in British Columbia. E. D. Ingall (Deals specially with the more newly-discovered silver veins of the West Kootenay district). Min Jour–Aug. 29. 2500 w.

*8078. The Gold Mining Revival in British Columbia (Editorial review of present prospects in this field). Min Jour–Aug. 29. 1700 w.

*8094. The Economical Use of Timber in Mines. H. W. H. (The points of economy in the use of mine timber, with methods considered in their economic bearing). Col Guard–Aug. 28. 4300 w.

*8095. Coal Mining in India (From the report of James Grundy, inspector of mines. Interesting information with description of four of the principal collieries). Col Guard–Aug. 28. 4000 w.

*8096. Further Application of Electric Haulage by Locomotives at the Marles Colliery. M. Baily (Setting forth the improvements in the new installation). Col Guard–Aug. 28. 900 w.

*8098. Interlocking Mine Cages with Anti-overwinding Apparatus (Illustrated description). Eng, Lond–Aug. 28. 2500 w.

Miscellany.

†7579. Note on the Formation of Gold Ore. K. von Kraatz. Translated by H. V. Winchell (Arguments to account for gold in its various forms). Am Geol–Aug. 2500 w.

7606. A Gold-Paved Valley. Dan De Quille (Some thoughts regarding the amount of gold deposited in the valleys of California by the rivers of the Sierras. The indestructibility of gold, and the strange places where it is found). Min & Sci Pr–Aug. 8. 2000 w.

*7625. The Manufacturing Industries of the West of Scotland (A comprehensive review of the iron-ore and coal output, and the pig-iron, malleable iron, and steel manufactures, with other information of a general character). Ir & Coal Trds Rev–Aug. 7. 20000 w.

*7654. The Occurrence of Anthracite. W. S. Gresley (From the *American Geologist*. Criticising Dr. Stevenson's theory of long exposure before covering, and leaning to that of the important influence of partial metamorphism). Col Guard–Aug. 7. 7500 w.

7665. Gas Power Transmission (Editorial review of Mr. Perry's plan for utilization of culm in generating gas for power transmission). Ry Rev–Aug. 15. 1500 w.

7672. Against Petroleum Refineries in Germany (Reviews the opposition of the Brown Coal mining industry). Am Mfr & Ir Wld–Aug. 14. 1000 w.

7674. Diamonds, Where They Occur and How to Search for Them. Melville Attwood (Describes the various types of placer deposits, and the method of examining the gravel). Eng & Min Jour–Aug. 15. 700 w.

*7686. Krupp's Oxidation Experiments with Iron and Steel Plates. H. Otto (Results of twelve years experiments on annealed and unannealed iron and steel of varying composition). Ir & Coal Trds Rev–Aug. 14. 1200 w.

7751. The Petroleum Industry of Sumatra. F. Stampfel (General description of field stated to be very rich in petroleum). Am Mfr & Ir Wld–Aug. 21. 1500 w.

7760. Alabama Furnace Burdens. William B. Phillips (Comments upon the frequent change of burden as an unfavorable feature in Alabama practice). Ir Tr Rev–Aug. 20. 2000 w.

7761. A Coal Handling and Storage Plant (Illustrated descriptive account of the Illinois Steel Co.'s South Works plant, at South Chicago, Ill). Ir Tr Rev–Aug. 20. 500 w.

7826. Basic Steel Rails (Tests of defective basic rails discussed with some notes of European specifications and practice, both as to basic and acid Bessemer rails). Eng News–Aug. 27. 1300 w.

†7874. The Genesis of the Talc Deposits of St. Lawrence County, N. Y. C. H. Smyth, Jr. (The origin is stated to be complex, and to lie in the metamorphism and subsequent exposure to carbonated water, of a bed of impure siliceous and magnesian limestone). Sch of Mines Quar–July. 2500 w.

†7879. The Gold-Fields of Guiana. Thomas Dalgleish (An Arizona miner's adventures in the disputed territory). Century Mag–Sept. 3000 w.

7892. Missouri Granites. Charles R. Keyes (Abstract of article in *Stone*. Describes the occurrence, varieties and characteristics). Eng & Min Jour–Aug. 29. 3300 w.

*7941. The Witwatersrand Chamber of Mines (Some particulars of its constitution with facts from its seventh annual report). Commerce–Aug. 19. 1100 w.

*7961. Quackery in Mining Education (Criticism and reply of Prof. Edgar Kidwell, based upon his contribution to the *Engineering Magazine*). Can Min Rev–Aug. 2000 w.

*7962. The Coal Supply of Canada (A brief summary of hints as to Canada's undeveloped resources). Can Min Rev–Aug. 700 w.

7966. Pine Creek District, Colorado. H. L. McCarn (A descriptive account). Min & Sci Pr–Aug. 29. 2000 w.

MUNICIPAL ENGINEERING

Condensation as Related to the Production of Naphthalene.

THE genesis of naphthalene, that *bête noire* of the gas manufacturer, has of late been made the subject of close study, with a view to its possible prevention. A great variety of suggestions have been made as to its possible cause, and its relation to temperature has been, perhaps, as plausible a suggestion as any. However, experiments with slow, rapid, hot, cold, and fractional condensation have led to no definite conclusion or practice, and, still groping for cause and remedy, the gas-making fraternity appears to be as much puzzled as ever upon the genesis of naphthalene and its effective prevention.

A paper recently read by M. Ymonet before the Société Technique du Gaz—an abstract of which we find in *The Gas World* (Aug. 8)—details an attempt to follow out at Rennes M. Godinet's method practised at Vichy,—to wit, abrupt cooling even to a temperature below that likely to be encountered during distribution.

M. Ymonet said that the apparatus used at Rennes was exactly like that employed by M. Godinet at Vichy, but the results were extremely bad; everything that could choke was choked with thick tar and naphthalene. Three chillings were employed, and to the sudden changes of temperature thus effected the bad results were attributed. Clearly, the conditions in the Vichy experiments must have been quite different from those at Rennes. At any rate the climates are said to be different, and at Vichy the greatest output is in summer, while at Rennes this is not the case. Therefore, at Rennes, after the failure of M. Godinet's method, the principle of progressive cooling by successive steps was tried with entirely satisfactory results.

"When they first appear, the products consist of different materials, each of which has its own boiling-point, and therefore its own temperature of condensation. The whole of the condensing apparatus was put under cover, all at the same exterior temperature; the condensation then took place under continuous cooling, and each constituent found its own condensing-point for itself. Naumann has found that the presence of water vapor facilitates the boiling of hydrocarbons, and lowers their boiling-point. Generally, in a mixture of vapors, when one of these vapors touches its boiling-point, it displaces the boiling-point of the vapors with which it is mixed; or, as M. Brémont stated it to the Société Technique in 1877, in a mixture of several vapors, when one of these vapors attains its condensing point, it displaces the condensing point of the vapors with which it is mixed. But precise data are wanting, and hence uncertainty and controversy. At Rennes there has been no deposit of naphthalene at all, either in the mains or at the works, since the change of method. One thing seems clear,—that the water ought, at latest, to condense at the same time as the tars, and, in any event, before the light tars do. Under the former system, water was found deposited even as far on as the purifiers: now there is practically none, except at first, and what there is has been carried forward as fine rain from the washers. It contains no ammonia, when pure water has been used in the last two columns, and contains exactly the same amount of ammonia as the washing liquor employed, if that be ammoniacal; so that it is simply a question of hygrometric saturation in the washers and of redeposition afterwards. In two works in the same town and using the same coal, ten years ago, the one had its pipes from the retorts exposed to atmospheric fluctuations of temperature, and the gas was suddenly condensed; the other had its pipes wood-jacketed, and the gas came in about 86° F. and was very slowly cooled. The former was often blocked with naphthalene, while naphthalene deposits were unknown in the latter."

From his experiments the author con-

cludes "that the gas leaving the condensers (there being no shock condensation) contains, in the form of very fine fog, a certain quantity of water and light oils holding a small quantity of naphthalene in suspension; that this is not removed by simple condensation, but is filtered off by the purifying material, together with, possibly, a slight excess of naphthalene carried by the gas itself; that the heating of the purifying material causes it to dry up, and the steam produced lifts the naphthalene, which condenses on the purifier lids. But then, while this is an ordinary result, M. Ymonet could get no such deposit of naphthalene at his own works at Rennes, even by chilling the purifier lids; which shows that slow cooling leaves practically no naphthalene in the gas. In hot condensation a large gas chamber is frequently employed; but the stream is not slowed down as is intended; it runs from entrance to exit direct, through an inert mass of gas. This chamber is kept warm, either by injection of steam, which is bad, inasmuch as it leads to great deposits of naphthalene; or by hot jacketing; or by a low-pressure steam worm in the chamber, which is good, for it insures thorough admixture, and prevents the establishment of a direct current from entrance to exit, while the temperatures employed can be regulated with the greatest ease. These temperatures should not exceed from 104° F. to 122° F.; else the water and the heavy tars will not condense out together, as they should, and the result may be the deposition of naphthalene further on."

It is claimed that the lighting power of the gas is improved, but the extent of the improvement is not stated.

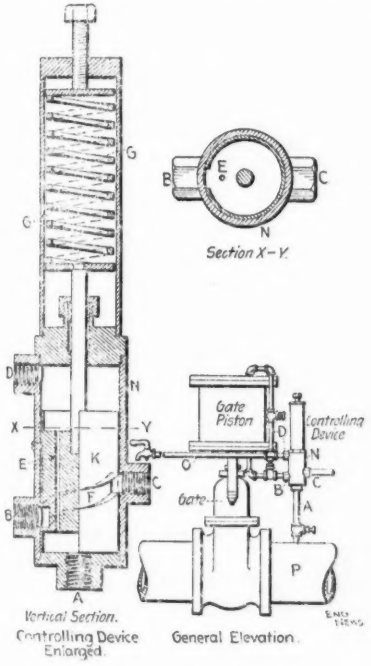
An Ingenious Gate-Opening Device.

MR. A. L. ADAMS, member of the American Society of Civil Engineers, has communicated to the *Engineering News* a drawing and description of a very ingenious hydraulic device for opening and closing gate-valves at a distance. Omitting his statement of the exigencies at Astoria, Oregon, which directed his mind to the production of this device, we note a prefatory remark that the operating of gates from a distance "is often desirable of accomplishment, especially in connection with the use of stand-pipes and direct pressure for fire protection, and to accomplish the speedy closing of large supply-mains in case of disastrous breaks."

We have reproduced the cut from *Engineering News* to which the description refers, and the description itself, on the principle of pushing along a good thing.

"In the cylinder, N, is a close-fitting piston, K, which moves in opposition to the spring, G. The cylinder, N, has provision for four pipe connections, A, B, C, and D. Connections B and C freely communicate together by way of the inclined port, F, cut around the piston, when the piston is at the lower end of the cylinder. When the piston is raised, the opening, C, is closed, and the opening, B, has free communication with the opening, A. The opening, D, is always unobstructed, whatever the position of the piston. A small hole is drilled through the piston longidinally, as shown at E, which gives free communication between the two ends of the cylinder. This hole is drilled of such size as to have a less delivering capacity under the pressure at which the gate operates than the small pipe extending from the governor to the point from which the gate is to be operated. In operating, A is connected with the pressure pipe in which the gate is placed, a screen being inserted between the main and the governor to prevent the passage of sediment; B is connected with the lower end of the gate cylinder; C with the waste; D with the upper end of the gate cylinder with a tee connection, in one branch of which is connected the line of small service pipe leading to the station from which the gate is to be operated. At the end of this pipe is placed a stop cock or other convenient means of opening and closing the pipe. Under normal conditions this cock is closed, the water has free access from the pipe, P, through A, E, and D to the upper end of the gate cylinder, thus acting on the gate piston and keeping the gate closed. There being an equilibrium of pressure in the two ends of the governor cylinder, the piston remains at the lower

end of the cylinder. When it is desirable to open the gate, the pipe at the controlling station is opened, releasing the pressure in D, causing the piston to be thrown to the upper end of the cylinder, which act closes C, and opens B to the passage of the fluid from A, which, acting on the lower end of the gate piston, causes the gate to open while the water from the other end of the gate cylinder passes off through the



pipe, O, at the controlling station. By closing the pipe at the controlling station, equilibrium is again gradually restored in the two ends of the governor cylinder through the opening, E, when the spring, G, throws the piston to the lower end of the cylinder, releasing the water from the lower end of the gate cylinder through the openings and movable port B, C, and F, while the pressure, being again applied to the upper end of the gate piston, causes the gate to close. By reversing the connections between the governor and the gate cylinder, the gate can always be kept open, instead of closed, while the pipe at the controlling station is kept closed."

Mr. Adams states that "the governor has operated perfectly from the very first, and responds instantly to the opening and closing of the cock at the governing station, and the gate operates without production of appreciable ram in the pipes. A check-valve, placed in the supply-pipe from the lower reservoir closes with the back pressure, cutting out a reservoir" (supplying domestic service) "while the fire pressure is on.

The Prepayment Meter System at Lille, France.

THIS system appears to have met with remarkable success in France, in striking contrast with the result in some English towns. Probably local—perhaps national—reasons exist for the difference. Without entering upon this question, *The Gas World* prints an abstract from a paper on prepayment meters read by Melon before the Société Technique, from which we condense the following statements.

The town of Lille, including its suburbs, has a population of about 300,000. About one hundred new prepayment meters are put in every week, the experiment being about eleven months old at the date of the paper. The total number of subscribers at 30th April, 1896, was 14,725, or 1 for every 49 inhabitants, this being greater by 22 per cent. than the corresponding number at 30th April, 1895. During the year the average of new pre-payment consumers has been 296 per month; of ordinary consumers, 19, as against 22 for the whole of the past ten years. The prepayment consumers are, therefore, people who would not have become consumers but for the new facilities: and in number they are equal to the new ordinary consumers brought in during thirteen years with one of the two gas companies in the town, and during seventeen with the other. The classes that have adopted the new system are, in the order of number: (1) wine shopkeepers, etc.; (2) commercial employees, business men, doctors, engineers, and students; (3) foremen and home workmen; (4) bakers, grocers, butchers; (5)

haberdashers, barbers, laundries; (6) functionaries, railwaymen, teachers. The working class—properly so called—has not yet patronized the prepayment meters. There have been put in 3,198 of these meters, 951 of which were put up where the use of gas had been given up, but the fittings left standing; and 55 ordinary meters have been replaced by the prepayment meters. Funnily enough, nineteen of these were for troublesome consumers who would not pay their gas bills promptly, and have been (whether at their own request or not, M. Melon does not say) put on a pay-as-you-go system. Six consumers broke open the meter, extracted the coins, and fled by night; total lost from this cause, 18s. 9d. The total money collected in these meters has been £3,681. The average consumption has been about 840 cubic feet per meter per month. Advertising has cost £252 (this will be no longer necessary), and commissions to collectors £254. The receipts will cover the cost of installation in four years,—that is to say, the slight extra charge made for gas will do so at present rates of consumption.

Excess in Engineering Specialization.

UNDER the title "The Engineering of the City Engineer," *The Engineering Record* (Sept. 5) editorially discusses the increasingly-diversified duties of city engineers, and argues that the specializing of engineering study and practice does not well fit engineers for these varying duties. Nay, it goes further, expressing a fear that specialization has gone too far. How, in the present wide field of engineering, any man can prepare himself to cover all parts of it before reaching an age at which most men begin to think of retiring from active business we are not told. Probably the broader range suggested by our contemporary is not intended to mean such a course of preparation. A narrower field, but yet not so narrow as many engineers now confine themselves to, is probably what is meant; and there is truth in what is said about knowledge outside of one's specialty fitting one all the more for the practice of his particular branch of engineering. Our contemporary says:

"We believe it cannot fairly be denied that the professional man, whether in engineering or anything else, whose educational training and experience have been confined within the narrow limits of a specialty, will be prepared with materially less efficiency to discharge even the duties of that specialty than if his early training and experience had been wider and of a character to afford him a more complete, and therefore truer, view of the things involved in his later practice.

"Again, the broad and general character of civil engineering will inevitably make the civil engineer an executive engineer, so to speak, in many cases requiring both a broad training and a broad prior experience, and the modern city engineer in a large city, discharging the duties demanded in connection with the varied municipal works of the present day, becomes essentially an executive professional man."

The German Gas Industry.

THE number of towns in Germany having gas-works for public supply has increased from 668 in 1885 to 724 in 1896. Concurrently the production at the old works has grown; so that the average yearly increase in the make of gas during that period has been 812,000,000 cubic feet, which is considerably higher than any former rate of increase. Taking the kilo-watt of electric energy as equivalent to thirty-five cubic feet of gas, which is a fairly just assumption when the different methods in which gas is consumed are borne in mind, the maximum productive capacity of the gas-works of German towns is about six times that of the electric lighting stations. The number of electric lamps and the number of gas-burners in use stand in nearly the same proportion. A computation from the increase in the make per hour during the same period shows that the gas production is growing at more than twice the rate at which the supply of electrical energy progresses. Thus far private electrical installations have not been taken into account. As a matter of fact, nearly double the number of lamps served by central stations are attached to small

installations; whereas gas is rarely made in private works. The conclusion that must be drawn is that electrical energy is not so well adapted for supply from central stations as from separate installations.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

*7564. Gas versus Electricity Direct from Coal. D. M. Dunning (Showing that the invention of Dr. Jacques offers no serious menace to the gas industry). Eng Mag-Sept. 3200 w.

7669. The Columnless Gas-Holder (Editorial disapproving this type of gas-holder and implying that no one of the type has yet met the requirements of a good gas-holder). Pro Age-Aug. 15. 1800 w.

*7678. The Repayment System in Lille (Results attained. An extraordinary success. Data). Jour of Gas Lgt-Aug. 11. 1200 w.

*7708. The Chemistry of Ammoniacal Liquor. W. Ivison Macadam (The obtaining of the maximum quantity of nitrogen from coal in the manufacture of gas). Jour of Gas Lgt-Aug. 18. 1400 w.

*7709. Notes on Gas Burners. A. Gibb (Read at the annual meeting of the North of Ireland Assn. of Gas Managers. Good and bad burners and how the latter may give rise to discontent among consumers). Jour of Gas Lgt-Aug. 18. 1400 w.

7711. The Relative Position of Consolidated Gas and Electric Light Plants. M. C. Osborn (Read at meeting of Pacific Coast Gas Assn. Why gas lost its popularity as an illuminant and the question of economy between running a consolidated plant, or a gas plant and electric lighting plant separately. Also discussion). Am Gas Lgt Jour-Aug. 17. 6000 w.

7750. Daubers Universal Gas Generator (General description). Am Mfr & Ir Wld-Aug. 21. 1000 w.

7783. Oil Tar and Its Uses. J. B. Grimwood (The uses to which oil-tar may be put and the transformation of the raw material into a state of usefulness other than its employment as fuel. Also discussion). Am Gas Lgt Jour-Aug. 24. 4500 w.

7784. Telescoping a Single Lift Gasholder While in Use. L. F. Fogg (Description of the method and appliances used for the purpose stated. Also discussion). Am Gas Lgt Jour-Aug 24. 1400 w.

7785. Gas Stoves. D. Decker (The proper conservation of energy, and the utilization of present waste forces that interfere with the economical distribution of gas). Am Gas Lgt Jour-Aug. 24. 5500 w.

7786. The Evolution of the Gas Meter. C. H. Dickey (A defence of the gas meter as an honest indicator of gas consumption). Am Gas Lgt Jour-Aug. 24. 1500 w.

7899. Water Gas. Charles F. Adams (A recital of interesting experiences with water gas in Portland, Ore). Am Gas Lgt Jour-Aug. 31. 3300 w.

7900. Enrichment of Coal Gas. O. M. Gregory (Read before Pacific Coast Assn. A comparison of results of three months trial with each of three enrichers—namely, shale, gasoline, and petroleum oil. Experiments were made in San José, Cal. Discussion). Am Gas Lgt Jour-Aug 31. 2800 w.

*7901. Difficulties I Have Met With, and How They Have Been Overcome. W. Miller (Experiences of a gas engineer in practice. Discussion). Gas Wld-Aug. 22. 6000 w.

7974. Relation of the Gas Company to the Stove Department. George E. Harris (Inducements for gas companies to put forth special efforts to encourage the use of gas stoves). Pro Age-Sept. 1. 1400 w.

*7976. The Theory of the Pressure-Register as Compared with the Common Gauge or U-Tube. B. R. Parkinson (Formulæ and diagrams). Jour of Gas Lgt-Aug. 25. 1500 w.

*8076. The Belfast Gas Works. James Stelfox (Paper read before the Inst. of Mech. Engs. Illustrated description, historical and general). Engng-Aug. 28. 4000 w.

Sewerage.

7584. The Sewerage of Victoria, B. C. E. Mohun (Read before the Canadian Soc. of Civ. Engs. An interesting and instructive general description). Can Eng-Aug. 4400 w.

*7617. Treatment of Refuse in Liverpool (Historical. Covers the last fifty years). Arch, Lond-Aug. 7. 2000 w.

7829. The Sewers and Sewage Farms of Berlin (Review of a report made by the French government engineer, F. Launay, with illustrated description). Eng News-Aug. 27. 4400 w.

*7888 Some Recent Experiments in Sewage Treatment at Exeter. Donald Cameron (Abstract of a paper read before the British Inst. of Public Health at Glasgow. The system described is based upon the idea of forwarding to fullest extent the work of natural agents). Engng-Aug. 21. 2500 w.

7982. Visiting the Sewers of Paris. From *Le Genie Civil* (Illustrated description by an eye-witness, with map of itinerary followed in visits to the sewers). Sci Am Sup-Sept. 5. 1100 w.

*8068. Sewage and Sewage Farms. J. H. Garrett (The faults of the system as at present practiced in many places, and their remedies). San Rec-Aug. 28. 2000 w.

Streets and Pavements.

*7571. The Manufacture and Use of Brick for Street Paving. H. K. Landis (Showing the processes of making paving-brick, the qualities

desirable in it under different conditions and the methods of testing it). Eng Mag-Sept. 3300 w.

7917. Paving in Toronto (Experience with different kinds of paving and conclusions derived from results). Eng Rec-Aug. 29. 1200 w.

*7938. Street and Road Paving in Germany. Robert Grimshaw (General description). Munic Engng-Sept. 1700 w.

*7939. Some Neglected Points in Municipal Work. H. K. Landis (Defective specifications for street paving are held responsible for faults in work). Munic Engng-Sept. 800 w.

Water Supply.

7583. The Storage of Water in Earthen Reservoirs. Samuel Fortier (A paper read before the Canadian Soc. of Civ. Engs. A very able and elaborate article. The problem discussed is stated and partly handled in the first part, numerous data being presented, and an account of experiments in compacting soils and sub-soils, carried out at the experiment station of Utah is given). Can Eng-Aug. Serial. 1st part. 4000 w.

†7608. Is Filtration a Perfect Safeguard? (An editorial negative answer is given to the question propounded. The contingency that at times filters will fail to act, is asserted as ever existing. Examples of imperfect filtration are cited). Ind Eng-July 18. 2000 w.

*7624. The Stockport District Water-Works: Description of Borehole, etc., near Wilmslow. T. Molyneux (Abstract of paper read before the Brit. Assn. of Water-Works Engs. Description of a well 180 feet deep, and nine inches in diameter, from which water is raised 120 feet to the surface by a lift-pump at the rate of more than 750,000 gallons per day. Also discussion). Jour of Gas Lgt-Aug. 4. 2400 w.

*7652. The Use and Misuse of Water. R. E. W. Berrington (A paper read before the Brit. Assn. of Water-Works Engs. Waste of water and its prevention by regulation and restriction in the use of certain plumbing appliances, and the employment of meters, are the topics discussed). Eng, Lond-Aug. 7. 2500 w.

7666. The San Francisco Aerating Plant (Illustrated description). Eng Rec-Aug. 15. 300 w.

*7676. Hydro-Geology and Hygiene: Law and Legislature (Abstract of paper read by C. E. De Rance before the British Assn. of Water-Works Engineers. The relations between hydro-geology and hygiene are set forth and their study is urged as related to sanitary legislation). Jour of Gas Lgt-Aug. 11. 4000 w.

7698. Test of Water-Bearing Gravel at Beaver Falls, Pa. (Illustrated description of an interesting experimental investigation). Eng News-Aug. 20. 2400 w.

7700. A 42-Inch Hydraulic Valve (Illustrated description of a hydraulic piston attachment for opening and closing large gate valves). Eng News-Aug. 20. 400 w.

*7740. New Reservoir, Bury (Illustrated detailed description. Further illustrations to follow). Eng, Lond-Aug. 14. 1000 w.

*7743. The Venturi Water Meter (Illustrated description of a complete meter for a 5-ft. main). Engng-Aug. 14. 500 w.

7825. The Water-Works of Colorado Springs and the Strickler Tunnel (Illustrated detailed description). Eng News-Aug. 27. 5000 w.

7828. A Device for Operating a Gate from a Distance by Hydraulic Power. A. L. Adams (Illustrated description). Eng News-Aug. 27. 700 w.

7871.—$1. The New Water-Works of Havana, Cuba. E. Sherman Gould (Illustrated detailed description). Trans Am Soc of Civ Engs-Aug. 5000 w.

*7977. Notes on Sinking, Timbering, and Refilling Concrete, and Puddle Trenches for Reservoir Embankments. W. Watts (Summary of a practical dissertation by an experienced water works engineer). Jour of Gas Lgt-Aug. 25. 2400 w.

*7978. Discharge Tunnels from Reservoirs. James A. Paskin (Read before the Britsh Assn. of Water-works Engineers. Summary of a practical discourse in which the outlets of reservoirs are chiefly considered). Jour of Gas Lgt-Aug. 25. 2800 w.

†7989. Peshawar City Water-Supply Project. Rai Bahadur Gauga Ram (Illustrated description, with editorial. First part gives description of the city and an account of the habits of the people). Ind Engng-July 25. 2700 w.

8015. The Chicago Water-Works Tunnel Extension (Illustrated detailed description). Eng Rec. Sept. 5. 1200 w.

8020. Filtration of River Supplies (Illustrated description of water-filtration at Paris). Fire & Water-Sept. 5. 1300 w.

8036. Utilizing Springs as Sources of Water Supplies for Towns. Louis E. Hawes (The origin and causes of springs, their availability for water supply, and examples of their utilization are treated). Eng News-Sept. 3. 4000 w.

Miscellany.

*7565. The Underground Topography of a City. Ill. Wm. Barclay Parsons (Showing how sub-surface conditions in cities are studied, and the nature of the facts revealed). Eng Mag-Sept. 4100 w.

7704. The Garbage Crematory at Portland, Ore. A. McL. Hawks (Information collected for Mr. Rudolph Hering and published with his consent. Illustrated description). Eng News-Aug. 20. 800 w.

*7707. The American Case Against Municipalization (Editorial review of the address of Dr. Allen R. Foote against municipalization of gas and electric lighting undertakings, delivered at the Street Lighting Convention at New Haven, Conn). Jour of Gas Lgt-Aug. 18. 1900 w.

7780. Municipal Construction and Ownership of Works for Public Accommodation (Editorial upon the recent decision of the Supreme Court declaring the rapid transit act of New York state constitutional). Eng Rec-Aug. 22. 800 w.

We supply copies of these articles. See introductory.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

The Cutting of Ties.

THE subject of the cutting of ties under the rail and its bearing upon the design and use of tie-plates continues to attract deserved attention in the engineering press.

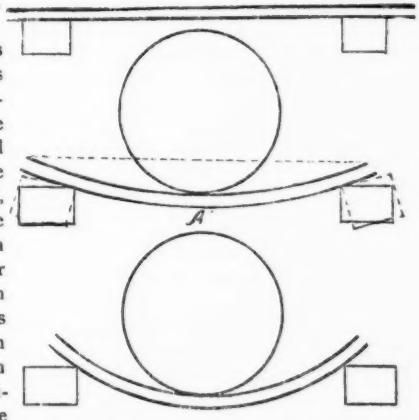
The Railway Review devotes an entire page to the discussion, in the form of a communication from Mr. Jerry Sullivan and a reply by Mr. Benjamin Reece. Mr. Sullivan is skeptical as to the importance of the sawing action to which Mr. Reece is inclined to attribute the entire trouble, and says:

"That it is not the sawing of the rails that causes the rapid destruction of ties may be almost proven by examining a turn-table. The ties near each end will be found cut down considerably, although all the others are in good condition. If the movement of the rail caused the cutting, all ties on the turn-table would receive the same amount of injury; but, because such is not the case, the destruction of the fiber appears to be caused by the compression and hammering of the rail, which reduces it to a dust or pulp, which in turn is blown out as fast as formed by the up and-down motion of the rail under trains. One cannot readily accept the statement that the very slight daily movement of rails is sufficient to saw ties half in two as rapidly as is done. It appears more probable that the grain of the wood is destroyed by indention of the rail, and that each passing wheel contributes its share toward the general result. Were this not the case; were it true that the creeping of the rail rubbing against the tie caused all the trouble,—why buy costly tie-plates, when a little strip of tin the width of the rail-base, if tacked with a couple of shingle nails across the bearing-surface of the tie, would prevent this rubbing, and save all the trouble with ties and tie-plates?"

Mr. Reece, without noticing the argument, develops his own position so forcibly that we reproduce the diagram and his accompanying exposition.

"A straight line of any length will extend from end to end a further distance than if it is curved or bent, for which reason the chord is necessarily shorter than the arc of the circle which it connects.

"Take, for illustration, a piece of flexible material, and suspend it between two end-supports. If you press down upon the center, you will cause a deflection which draws the ends toward the center, and, if



persisted in, would draw the ends clear from their support, as shown in diagrams.

"As the rail is correspondingly deflected by wheel pressure, the rail is slightly drawn from each end and over the face of the ties toward the point, A, and, when the load is removed, the rail returns to normal position shown by dotted lines, pushing back upon the ties in each direction the same distance it was drawn when deflected under the load. This forward and backward movement occurs more or less under every passing wheel. The observed change of position which we call creeping of the rail is simply the aggregate difference of the total movements of the rail in the one direction or the other, whereas

the cutting of the ties is due to the sum total of the movements in both directions."

With all respect to Mr. Reece's pre-eminent qualifications as an authority on the question, it still seems as if Mr. Sullivan appreciated a collateral truth of some importance. It is hard to believe that the cutting is not due in part to the shearing of the wood-fiber by the edge of the rail flange, under a direct downward blow from the wheel; but this cause may be a minor one, and would naturally be more largely operative in such situations as Mr. Sullivan selects for his illustration, where the downward blow is accentuated by the yielding of the structure supporting the track and ties.

The Improvement of Braking Efficiency.

THE *Railway Master Mechanic* has recently published an interesting discussion of the braking power of passenger trains, which it regards as needlessly inefficient, to the great increase of the risks of travel. Indeed, the correspondent who contributes the paper is deeply pessimistic, and adopts as his text the statement that, "at a meeting held some time ago of one of the railway clubs, a superintendent of motive power, whose remarks are always worthy careful consideration, made the following observation, while discussing the design of passenger cars and the general make-up of passenger trains: 'Taking the train as a whole, I believe that we could not get up a better machine for killing people, in case of collision, than the present passenger train.'"

This is, without doubt, a very great over-statement of the case. We could get up a very much better machine, and need go back but a few years in railroad history to find such a machine exemplified in the passenger train of a quarter century ago, which was not only immeasurably behind present standards in braking-efficiency, but added the deadly risks of bad couplings, defective platforms, and weak construction, and piled upon these the horrors of the oil-lamp and the car-stove.

One of the most striking features of the modern accident is the comparative immunity enjoyed by passengers, in the great majority of cases even of serious collision or derailment.

This, however, is far from saying that safety may not be still further and very greatly increased, and the suggestion of the *Railway Master Mechanic's* correspondent may be fruitful of good in this direction. He says:

"Bearing in mind the fact that there are many cars equipped with six wheel trucks and only four wheels of each truck provided with brakes, which cars are running in trains with cars having all wheels provided with brakes, an average train may be assumed as follows. Two express cars with six-wheel trucks, four wheels of each provided with brakes; weight, 65,000 pounds. One baggage car, four-wheel trucks; weight, 60,000 pounds. Two day cars, four-wheel trucks; weight, 65,000 pounds. One day car, 80,000 pounds, and three sleeping or other heavy cars, 85,000 pounds, each of which has six-wheel trucks, but only four wheels of each provided with brakes. The weight of the locomotive may be distributed as follows: 70,000 pounds on driving-wheels, and these wheels provided with brakes; 30,000 pounds on truck wheels, and these without brakes; 37,000 pounds on two four-wheel trucks, and all wheels equipped with brakes.

"Each weight assumed above is the weight empty. Assuming that the braking pressure on each wheel equipped with brakes is 90 per cent. of the weight on the track under the wheel, then the total braking pressure of the train is about 73 per cent. of the total empty weight. This is the best result that will obtain under the conditions named, and, with the distribution of weight as assumed, is better than could be obtained in practice.

"The other extreme condition will develop from assuming the maximum loading for each car and for the locomotive in working order, and it is found that the total braking pressure is about 60 per cent. of the total weight of the train. Were every wheel provided with a brake, and the braking pressure be 90 per cent. of the pressure under each wheel of the empty car, then the total braking pressure

would be about 82 per cent. of the total weight of the loaded train.

"The fact that in many instances the braking pressure is only about 60 per cent. of the weight of the train, whereas it might be about 80 per cent., indicates one way in which the number of accidents might be lessened."

A further risk suggested is that due to the fact that the middle of the train, as ordinarily made up, is braked much more nearly to the maximum than either end. "Stated in tons, the arrangement is as follows: 120 tons in the middle braked to 80 per cent., 200 tons on one end braked to 48 or 50 per cent., and 150 tons on the other end braked to 55 per cent.

"Considering the generally lighter construction of the day cars and their arrangement in the middle of the train, perhaps it should not be surprising if they telescope or 'double up' in a collision."

We believe that derailment of the middle of a train from emergency braking has occurred; but statistics hardly show the danger suggested by the *Master Mechanic's* correspondent to be a very present one.

The Risks of Railroading.

NOT long since, in the department of Mining and Metallurgy in THE ENGINEERING MAGAZINE, we reviewed the surprisingly low ratio of accidents to number of employees engaged in the commonly-esteemed hazardous occupation of mining.

The subject is recalled by *The Colliery Engineer and Metal Miner* in an article entitled "Railroading More Dangerous than Mining," from which we extract the following interesting comparison. The figures, so far as they relate to railroad accidents, are correctly taken from the advance sheet of statistics for the year ending June 30, 1895, issued by the interstate commerce commissioners, and are therefore authoritative.

Out of 785,034 persons employed, "during the year there were 1,811 employees killed, and 25,696 injured. These figures, compared with those of the previous year, show a decrease of 12 in the number killed, and an increase of 2,274 in the number injured.

"One employee was killed for each 433 employed, and one employee was injured for each 31 employed. This ratio is based on the *total* number of employees, including officials, clerks, telegraphers, etc. Of the class known as trainmen,—that is, engineers, firemen, conductors, and others whose service is upon trains,—it appears that one was killed for each 155 in service, and one was injured for each 11 in service.

"This latter class of employees are those that for purpose of comparison should be classed with the mine employees, as, like mine employees, they are the class that take the risk.

"Now, for purposes of comparison, we will take the mine inspector's statistics of Pennsylvania, for the year 1895.

"In the anthracite regions, admittedly the most dangerous mining field, there were 143,610 employees. The fatalities numbered 422, and the number of injured was 1,120. These figures show that there was one killed for each 340 employed, and one injured for each 128 employed.

"In the bituminous fields of Pennsylvania there were 84,904 persons employed, the fatalities numbered 155, and the number of injured was 419. These figures show that in bituminous coal mining there was one fatality for each 548 employees, and one employee injured for each 203 employed.

"Now, it must be remembered that, owing to more extensive mines, greater use of machinery, the presence of more gas, etc., etc., the coal mines of Pennsylvania are the most dangerous on this continent.

"Taking both anthracite and bituminous mining together, we find that there were 228,514 men employed in 1875, and that there were 577 fatalities, and 1,539 men injured. Or, there was one life lost for each 410 employees, and one person injured for each 148 employed. Comparing these ratios with those given for railroading, we find that railroading is almost three times as dangerous as coal mining."

The point in which the excessive risk of

railroading appears most striking is the ratio of those injured to those in service. The proportion of one in eleven is appalling, and the mind of the reader reverts at once to the link-and-pin and the defective grab-iron.

It is interesting to note the comparison between English and American figures as to mining fatalities. In 1895, the death rate (from accidents) of underground workers, under the coal mines act, was one per 615 employed, and of similar workers, under the metalliferous mines act, one per 418 employed.

The figures for the English coal mines are much more favorable than for the American bituminous mines, which most nearly compare with them. We would be glad to see the figures of English railroad casualties among employees, and to note whether or not they would show a similar betterment as compared with the record in this country.

The Thousand-Mile Ticket in England.

IT is very remarkable, considering the long existence of so many excellent channels for the free interchange of ideas between this country and Great Britain, and the constant flow and reflux of travel between the two countries, that wide differences of practice exist in railroad transportation matters, where, above all, we might presuppose the fullest mutual study of methods and results, and the free adoption by both countries of that which had been successfully tried in either, so long at least as it was not evidently adapted solely to conditions peculiar to the country in which it originated. It is not long, however, since we drew attention to the English railway clearing-house as a highly-developed institution of great value, but comparatively new to American railway men prior to the admirable exposition of its workings made by Dr. William Taussig before the Commercial Club of St. Louis.

In the August issue of THE ENGINEERING MAGAZINE we commented upon some points of English practice with regard to special excursion rates, which seemed well suited to adoption here.

Now, as an amusing counter-development, comes the appended extract from the (British) *Railway Times*, bringing out the fact that the thousand-mile ticket, which we would regard as an indispensable part o our passenger-rate system, is almost wholly unknown and apparently very little admired on the other side. This is the way the *Railway Times* regards it:

"The North-Eastern Railway Company seems to have tentatively decided to adopt Artemus Ward's motto: 'You can't go in without paying, but you can pay without going in.' In arranging to issue at reduced rates books of coupons available for twelve months over the whole of the North-eastern system, and for journeys amounting in the aggregate to one thousand miles, the directors are practically saying to the world at large: 'You can't travel without paying your fare, but you can pay your fare without traveling.' If the purchaser of a book of coupons succeeds in using the whole number, he will have secured one thousand miles of first-class railway travel at an average fare of 1¼d. per mile. The idea will doubtless prove attractive to many who, like Mrs. Gilpin, have a frugal mind; but it is never likely to achieve any wide popularity while it remains hedged about with restrictions so numerous and so irritating as those which official ingenuity has devised for the Northeastern 'new departure.' The coupons are not, it seems, to be directly available as tickets; they must be exchanged at the booking-office for the ordinary ticket before the journey begins. Nor will it be sufficient to produce to the booking-clerk the exact number of coupons representing the distance to be traveled. The book itself must be produced for his inspection, and its proud possessor will resemble no one so much as the irascible old lady of the comic papers who carried about a huge family Bible under her arm in order to convince incredulous booking-clerks that her son was under twelve years of age. Probably these regulations are intended to preserve the legend of non-transferability, but the Northeastern, in issuing these coupons, is going so far in the direction of making railway tickets transferable that it is diffi-

cult to discern any logical reason for not going the rest of the way."

The restriction, though hardly as troublesome as the *Times* infers, seems needless; but it is a very easy step to the American practice of permitting the surrender of the coupons on the train instead of at the "booking-office."

The *Railway Times*, in conclusion, while admiring the enterprise of the North-eastern Railway Company in initiating the change, "shrewdly doubts whether any large section of the public is anxious to pay five guineas for the privilege of traveling a thousand miles on the North-eastern system. As Punch remarked, *apropos* of the injunction not to marry one's grandmother, 'Who on earth wants to?'"

In America a very great many do desire, not to marry their grandmothers, but to avail themselves of an excellent means of cheapening their frequent, but indefinitely located, journeys over one road or system. Probably the British "commercial traveller," at least, is similarly minded.

The Passing of the British Railway Carriage.

REFERENCE has been made recently in these columns to the possibility at least, if not the probability, of some radical changes in the model of the English railway carriage, which might bring the British passenger rolling-stock of the near future very near to American types of construction, and thus exercise a far-reaching influence, extending, perhaps, to important modifications in standards of track and permanent way generally.

It is significant, in this connection, to note the widespread attention attracted to the new "corridor-trains" which have been recently introduced through the competitive struggle for business between London and Scotland by the east and west coast routes.

Our contemporary, describing the "beautiful new trains," says: "The cars have numerous features that are American. They have corridors the length of the cars, end doors, Gould vestibules, couplers and platforms, Westinghouse brakes, and car-heating apparatus of American manufacture. The cars are each sixty-six feet long." Even ultra-conservative *Engineering* is moved to remark that, "after a very long life, the British railway carriage, with its independent compartments, begins to show signs of having passed its meridian."

So far, it seems to be assumed that, because "this innovation is on a long-distance train, it is probable that, if it finds favor at all, it will be confined to long-distance travel," but it does not need much more than half a prophet to foresee that the innovation will not stop long in any such intermediate stage.

There is, indeed, another consideration which may exercise a powerful influence in bringing about the change, and that is one which is thus introduced in *Transport*:

"The question of outrages in railway carriages is still attracting widespread attention. A lady writes, declaring that it is not only timid and nervous women who feel afraid of railway-traveling under existing conditions. 'I have,' she says, 'traveled for a good many years, and have never experienced the slightest annoyance. But I am none the less aware of the risks which I, in common with every woman, run from the possibility of association with ruffians, criminals, or drunken men. It is not merely the lunatic or the habitual criminal that one has to fear; it is any man whom drink or other exciting cause has for the moment deprived of self-control. Every woman who has traveled at all has painful memories of scares in railway carriages, and, however little these scares may have been justified by actual annoyance, the remembrance is far from pleasant. I recollect setting off once for a holiday with a lady friend from a large terminus. We secured an empty third-class carriage, and, just as the train was starting, two men, evidently tipsy, jumped in. It was too late for us to change, and I shall carry in my mind the image of the lengthening faces of the friends who had come to see us off, as the train steamed slowly out of the station. Fortunately our tipsy companions slept peacefully; but, if they had chosen to make themselves un-

pleasant, I don't know what we should have done, for they could easily have prevented us from getting to the communicating cord.'"

The writer recounts another instance where relief from a very unpleasant situation on a midnight train was obtained by tipping the guard, but resumes:

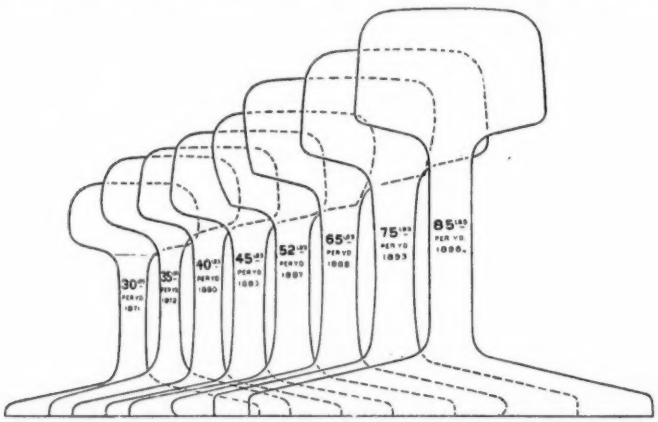
"Suppose, however, that in my place had been a young servant or shop-girl, or even a timid governess, or a girl unused to traveling. She would not venture to call up the guard, and would simply accept whatever accommodation she found. Actresses, musicians, and other women whose professions involve evening engagements are particularly exposed to risk, though, for the matter of that, the worst outrages have, as far as my memory serves me, been committed in daylight. Nor does it matter whether a woman is young or old, plain or pretty, for robbery is a sufficient cause for violence in any case, and sometimes the outrage seems to be motiveless except for the criminal instinct prompting to violence or blackguardism."

Another possibility, even more unpleasant, has recently been noticed in *The Outlook*,—the danger to male travellers from the opportunity given to a miserable class of female blackmailers.

Transport reaches the very inefficient conclusion that "it is quite evident that the railway companies have done as much as can be reasonably expected; and, indeed, it is extremely doubtful if they can greatly improve matters, unless, indeed, they introduce corridor trains throughout their entire systems, and that they can hardly be expected to do, for the expense would be enormous." If the facts are as alleged, the railroads will no doubt have to "greatly improve matters," regardless of the expense; and the demand for increased comfort may be a stronger operative influence than the fear of outrages.

A Quarter-Century of Railroad Growth.

THE annexed cut, showing, by superimposed sections, the rapid increase in size and weight of rails used on the Denver & Rio Grande Railway during the last twenty-five years, epitomizes, perhaps as strikingly as it could well be done, the marvellous growth of the railroad in the last quarter-century.


30 LBS. PER YD. 1871.
35 LBS. PER YD. 1872.
40 LBS. PER YD. 1880.
45 LBS. PER YD. 1887.
52 LBS. PER YD. 1887.
65 LBS. PER YD. 1888.
75 LBS. PER YD. 1893.
85 LBS. PER YD. 1896.

COMPARATIVE SECTIONS OF RAILS USED ON THE DENVER & RIO GRANDE R. R. FROM 1871 TO 1896.

Engineering News, from which the cut is reproduced, comments upon the various sections as follows:

"There are eight sections, ranging from 30 to 85 pounds per yard, and dating from 1871 to 1896, and these represent three different types of head. The first two (30 and 35 pounds per yard) have heads with round corners and sides, the second approximating somewhat to English sections. The next two (40 and 45 pounds per yard) have heads with out-

ward flaring sides and very round corners. The next two (52 and 65 pounds per yard) have inward flaring heads, which is a distinctly objectionable form of section; and it will be noted that, while the first of these (52 pounds per yard) has rounded sides to the head, the second (65 pounds per yard) has the sides very nearly plane. In the last two rails (75 and 85 pounds per yard) the section approximates to what is now practically the standard type of section, although the top corners of the head are of rather larger radius than is usually considered advisable."

The illustration might be even more striking, though possibly less representative of the general average, if it were taken from one of the largest roads.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

Electric and Street Railways.

*7619. The Brand Electric Railway System (Abstract of paper by Mr. Franklyn read before the Tramways Inst. of Great Britain and Ireland. Illustrated description with sweeping condemnation of the trolley system. The discussion following severely criticises the system described). Elec Eng, Lond–Aug. 7. 4000 w.

7647. Speed, Power and Efficiency of Electric Motors for Locomotives. D. L. Barnes (Abstract of a paper read before the Western Railway Club. Exhibits the extreme simplicity of the principles governing the action of the direct current series motor, and of the relation between speed, power and efficiency). Ry Rev–Aug. 8. 2500 w.

*7692. Meckenbeuren – Tettnang Electric Railway, Würtemberg, Germany (Illustrated description of a small plant possessing features of interest). Elec Rev, Lond–Aug. 14. 800 w.

*7694. Combined Conduit and Trolley Road (Editorial dissertation upon the uselessness of such combinations in most cases, and the difficulties introduced by them). Elec Rev, Lond–Aug. 14. 900 w.

7713. New Underground Electric Railways in London (Present status and projected equipment of all underground London railways with electric motors. Map). Elec Eng–Aug. 19. 500 w.

7756. Gas Motor Tram Cars (Illustrated description of the Luhrig system). Sci Am Sup–Aug. 22. 1200 w.

*7770. Compressed Air for Street Cars (Editorial, reviewing the failures and defects of compressed air, and contrasting it unfavorably with electricity). St Ry Rev–Aug. 15. 1800 w.

*7771. Dead Weight—Is It Profitable or Practicable to Reduce It? (A discussion of the question with strongly affirmative conclusions). St Ry Rev–Aug. 15. 1000 w.

*7772. The Successful Handling of Street Railways with the Dispatcher's Telephonic System. J. L. M'Lean (An exposition of the method, with map of route, forms for reports, etc). St Ry Rev–Aug. 15. 3000 w.

*7773. Niagara Power for the Buffalo Railway (Important details of the project, contracts, and proposed line-construction). St Ry Rev–Aug. 15. 1100 w.

7776. The Walker Company's Series-Parallel Controller System. William Baxter, Jr. (The controller is said to prevent the destructive sparking upon change from series to parallel connection or *vice versa*). Elec Wld–Aug. 15. 2200 w.

7777. The Rochester and Irondequoit Park Railway (Devoted principally to description of power installation of a successful electric road, replacing an unsuccessful steam railway). Elec Wld–Aug. 15. 900 w.

7798. Repair of Street Railway Apparatus (Relates to repairs of the electric motor and its connected mechanism. Instructions for motormen, illustrated by diagrams. The most frequent breakdowns and failures are named). Am Elect'n–Aug. 1500 w.

7806. The Midland Railway of Staten Island (Illustrated description). Elec Wld–Aug. 22. 1300 w.

7812. New York Street Railway Association (Announcement and programme of the September Binghamton meeting). W Elec–Aug. 22. 1000 w.

7817. The Electric Railway Up Mont Saleve, Geneva (Interesting illustrated description of an electric road ascending 4000 ft., with grades of 25%, and curves of 35 meters radius). Elec Eng–Aug. 26. 750 w.

7818. The Brighton-Rottingdean Sea Trolley Road (Illustrated description of a curious and interesting road). Elec Eng–Aug. 26. 350 w.

7837. Electric and Compressed-Air Street Cars. R. D. Williams (A discussion of mechanical efficiency, showing that while this is an important factor, it is not the most important factor in street railway practice). Am Mach–Aug. 27. 500 w.

7851. The Cleveland and Elyria Electric Railway (Illustrated detailed description). Elec Wld–Aug. 29. 600 w.

*7858. Electric Traction in the Isle of Man (General illustrated description of power installation, route, permanent way and equipment). Ry Wld–Aug. 5400 w.

*7859. Tramway Companies' Reports (Compilation of financial and traffic returns of a large

number of British roads). Ry Wld-Aug. 1500 w.

*7916. Street Cars Operated by Compressed Air (Statement of the important features of the Hardie system). Loc Eng-Sept. 1300 w.

†7953. The Electric Railway System of the Northern Coast of New Jersey (General Illustrated description). St Ry Jour-Sept. 2300 w.

†7954. The Electric Railway of Rome, Italy (Illustrated description). St Ry Jour-Sept. 1100 w.

†7955. The Street Railway System of Hanover. C. O. Mailloux (Illustrated description). St Ry Jour-Sept. 1100 w.

†7957. Studies in Economic Practice.—Milwaukee. C. B. Fairchild (A review of the Milwaukee system). St Ry Jour-Sept. 3000 w.

†7958. Some Lessons in Car Construction Taught by Old Cars. W. E. Partridge (An illustrated deduction of improved practice from past defects). St Ry Jour-Sept. 1300 w.

†7959. The Growth of Electric Railways in Southern New England (A review with tables and map). St Ry Jour-Sept. 1200 w.

†7960. Running Notches of Series Parallel Controllers Compared. S. L. Foster (A tabulation of data with deduction of results, and comparison of present and possible methods). St Ry Jour-Sept. 2000 w.

7985. The Boston Electric Subway (Illustrated description). Sci Am-Sept. 5. 1300 w.

8037. Paris Tramways, Past and Present (A brief review of their extent and operating policy). Eng News-Sept. 3. 600 w.

8063. The Trolley Conduit Railway in Springfield, Ohio (A descriptive account of the system which is said to give very gratifying results in operation). W Elec-Sept. 5. 800 w.

8065. Chicago's First Street Cars (From the *Chicago Tribune*. Historical review of the introduction of the street railway system in Chicago). W Elec-Sept. 5. 1000 w.

8082. The Akron, Bedford and Cleveland Electric Railway (Illustrated description). Elec Wld-Sept. 5. 1200 w.

8117. Long Distance and Heavy Duty Electric Railways. F. W. Darlington (A paper read before the Pennsylvania Street Railway Assn. A brief review and forecast from both the mechanical and the commercial side). Elec Eng-Sept. 9. 4200 w.

8118. The Hardie Compressed Air Street Car Motors in New York (A review of the system and operation, with conclusions unfavorable to its economy and its mechanical perfection. No actual figures of cost are given). Elec Eng-Sept. 9. 1000 w.

Equipment and Equipment Maintenance.

7627. Reduction of the Weight of Reciprocating Parts in Locomotives (Report of a committee of the Amer. Ry. Mas. Mech's Assn. The importance of the subject is set forth and material and design are considered as applied to the parts under discussion). Eng News-Aug. 13. 3800 w.

7725. The Future of Power Development (A comparison of steam, electricity and gas for locomotive engines). Ry Rev-Aug. 22. 1700 w.

7841. Instruction Car of the Wabash Railroad (Illustrated description). R R Gaz-Aug. 28. 2500 w.

7857. Break-in-Twos (Break-in-twos between cars equipped with M. C. B. type of coupler. To what extent do they occur? What are their causes, and how can they be prevented? Discussion at the Master Car Builders' Assn). R R Car Jour-Aug. 3000 w.

7860. Low Water and Burned Fire Boxes (Oil scale, forming below the water line and causing overheating there, is ascribed as the true cause of many explosions attributed to low water). Ry Mas Mech-Aug. 1100 w.

7861. Malleable Castings as Factors in the Reduction of Operating Expenses (The economy expected is in the reduction of weight and of repairs). Ry Mas Mech-Aug. 800 w.

7863. Traveling Engineers—Their Duties and What They May Accomplish. C. E. Slayton (Abstract of a paper read before the North-West Ry. Club. Gives the organization of their duties C. & N.-W. Ry. and strongly urges the value of their reports to the master mechanic). Ry Mas Mech-Aug. 2200 w.

*7894. Indicator Rigging for Locomotives. A. W. Gibbs (Describes an improvement in the device recommended by Prof. Goss. With full drawings). Am Eng & R R Jour-Sept. 600 w.

*7895. Forty-six-Foot Furniture Car—Chicago, Milwaukee and St. Paul Railway (Description and drawings). Am Eng & R R Jour-Sept. 1000 w.

*7896. Thermal Tests of Car Wheels (Describes tests and suggests the influence of form of wheels upon their behavior under such testing). Am Eng & RR Jour-Sept. 800 w.

*7897. Defects and Improvements in Locomotives (Deals chiefly with economy in fuel consumption). Am Eng & R R Jour-Sept. 1700 w.

*7911 Swindon Works (Illustrated description of the shops of the Great Western Ry., Eng). Loc Engng-Sept. 700 w.

*7912. West Shore Kinks (Illustrated description of shop devices and methods). Loc Engng-Sept. 2000 w.

*7913. Opposing Steel Cars (Cites arguments in favor of wooden cars, based upon German and American practice and experience). Loc Engng-Sept. 1200 w.

7920. Locomotive for Burning Culm—D. L. & W. R. R. (With photograph and full dimensions). Ry Rev-Aug 29. 500 w.

7923. Locomotive Boilers and Tubes (Conclusion of the discussion in the International Ry. Congress). Ry Rev-Aug 29. 1400 w.

*7929. Locomotive Building in Germany (Historical review and summary of important points in modern practice). Eng, Lond-Aug. 21. 2600 w.

*7947. Locomotive Counter-balancing. G. R. Henderson (Deduction and statement of rules with particular reference to the overlooked importance of the proportion of reciprocating

weights to balance). Jour Assn of Engng Soc–July. 1300 w.

8043. Car Frames of Wood and Metal. F. E. Stebbins (Diagrams and characteristic points of all principal types). R R Car Jour–Sept. 1500 w.

8044. Compressed Air in Car Painting. W. O. Quest (Illustrations and descriptions of the practice). R R Car Jour–Sept. 1000 w.

8045. Protective Paints for Metal Parts of Cars and Trucks (Symposium of correspondence from M. C. B.'s foremen and paint manufacturers, giving experience and suggestions). R R Car Jour–Sept. 1200 w.

8047. The Railroad Blacksmiths' Convention (Brief report of the proceedings and discussions). Ry Age–Sept. 4. 3000 w.

8066. Reinforcement of Cars on the Northern Pacific Railroad (Details of the methods used for increasing 40,000 lb. capacity cars to 50,000, with diagrams). Ry Mas Mech–Sept. 1200 w.

Maintenance of Way and Structures.

7697. Track Elevation, Chicago & Northwestern Ry., in Chicago (A general review of the character and scope of proposed work, and the methods to be employed). Eng News–Aug. 20. 2200 w.

*7735. Permanent Way of American Railways. E. E. Russell Tratman (An authoritative exposition and defence of American permanent way against British strictures). Eng, Lond–Aug. 14. 2000 w.

7762. Work of Steam Shovels on the Ann Arbor Road (Gives tabular statement of the work of a number of steam shovels, and information regarding the method by which the work was done). Ry Age–Aug. 7. 900 w.

7890. The New England Roadmasters' Convention (Committee reports on spring rail frogs, rail-joints, automatic switch-stands, elevation of curves and minor points). Ry Age–Aug. 28. 2200 w.

7921. The New Passenger Station at Providence—N. Y., N. H. & H. R. R (Illustrated description, with view of completed structure and diagram of station and tracks). Ry Rev–Aug. 29. 2300 w.

7922. Rail Cut Ties (Criticism of Mr. Reece's theory, that the cutting is due to longitudinal movement of rail, and Mr. Reece's rejoinder). Ry Rev–Aug. 29. 2200 w.

*7932. Liverpool Street Station Widening (Illustrated description of the extension of Primrose Street bridge). Eng, Lond–Aug. 21. 2200 w.

7950. Track Elevation at South Norwalk (An illustrated description of the permanent and temporary work). R R Gaz–Sept. 4. 1500 w.

8033. The Requirements of Tie-Plates for Railway Track. Benjamin Wolhaupter (A discussion of the action and wear of rail and tie under service load, and deduction of principles therefrom). Eng News–Sept. 3. 3800 w.

8038. Rail Sections of the Denver & Rio Grande R. R. (An interesting outline chart of the important sections adopted during the last twenty-five years). Eng News–Sept. 3. 600 w.

Signaling.

7644. Interlocking at Hartford (Description of a 64-lever manual plant at crossing of N. Y., N. H. & H. and N. E. R. R. with plan of switches and signals, dog sheet and locking sheet, and views of machine, lever and connections). R R Gaz–Aug. 14. 400 w.

7716. Signaling and Interlocking on the Union Elevated or Down-Town Loop, Chicago (Description of the installation and operation with plan of the tracks). R R Gaz–Aug. 21. 800 w.

*7915. The Latest Grade Crossing Collision (The Atlantic city collision, used to emphasize the importance of the human element even in the best mechanical systems). Loc Engng–Sept. 800 w.

Transportation.

*7568. Railway Pooling and the Reduction of Freight Rates. H. T. Newcomb (Showing the nature of pooling contracts and how they operate to lower railway charges). Eng Mag–Sept. 3400 w.

7642. New Express Trains in England. W. M. Acworth (Reviews the recent improvements in British passenger service). R R Gaz–Aug. 14. 1000 w.

7643. The Fast Trains Between London and Scotland. J. Pearson Pattinson (Gives in descriptive and tabular form. facts regarding typical British express service). R R Gaz–Aug. 14. 350 w.

7646. Thousand Mile Railway Tickets in England (Criticises strongly the value or advantage of the system as recently introduced on the North-Eastern Railway). Ry Rev–Aug. 8. 700 w.

7724. Regulation of Commerce (Abstract of the report of the Kansas Railroad Commission, concerning "reasonable rates"). Ry Rev–Aug. 22. 2500 w.

7835. English Facilities for Handling Freight—Hydraulic Cranes and Capstans (System illustrated by description of a typical freight house on a large English railway). Am Mach–Aug. 27. 1200 w.

7840. A Suggestion for an Improvement in Train Schedules. George B. Leighton (A plea for afternoon trains for runs of moderate length). R R Gaz–Aug. 28. 900 w.

7844. The Grain Exporters' Complaint (Rates on grain to New York, are made the basis of a discussion of the merits of this particular case, and of some general comment on rate making and differentials). R R Gaz–Aug. 28. 2800 w

7889. Have Transportation Rates Decreased? (Statistical figures reviewed to show the enormous reduction, in refutation of the political utterances of the free silver candidate). Ry Age–Aug. 28. 1000 w.

7919. Rules Governing the Loading of Lumber and Timber on Open Cars (Abstracted from pamphlet issued by the M. C. B. Assn). Ry Rev–Aug. 29. 2000 w.

7924. The Objection to "Pooling." E. W. J. (A defence of the maxim "combination in rates, competition in facilities"). Bradstreet's-Aug. 29. 1000 w.

8032. Notes on a Transcontinental Trip (The notes are of characteristic features of the train service on the various roads travelled over). Eng News-Sept. 3. Serial. 1st part. 3600 w.

8041. Discrimination Under the Short-Haul Clause (Summary of the Lynchburg case, with Interstate Commerce Commission ruling, denying the right to maintain higher rates for a shorter haul, even when the disproportion is caused by competitive reductions at the farthest point). Bradstreet's-Sept. 5. 900 w.

8046. Can Rate Cutting Be Prevented by Injunction? Opinion of Judge Simonton (The opinion is adverse to the court's power of interference in the case as presented, but implies that the limitations are from the special circumstances and not from general principles of law). Ry Age-Sept. 4. 1900 w.

Miscellany.

*7641. Lightning Express Railway Service (Criticises unfavorably a proposed 150 mile an hour "single rail" system, exhibited in model, on the ground that the weight of passengers has been ignored in calculating C. G. and effects centrifugal force). Elec Rev, Lond-Aug. 7. 1600 w.

7645. The Nippon Railroad of Japan. R. Unno, traffic manager Nippon Railroad, in *N. Y. Railroad Men* (Gives general account of the road and contrasts present and recent conditions in Japan). Ry Rev-Aug. 8. 800 w.

7663. A Railway Engineer (Reviews a criticism of American practice in Indian Engineering, and defends the system of entrusting work to practical mechanics under expert engineering supervision). Ry Rev-Aug. 15. 1400 w.

7664. Relics of the Big Four Railway (Historical notes on some early construction equipment, and the popular conception of railway undertakings sixty years since). Ry Rev-Aug. 15. 1700 w.

7695. An Atlanta View of the Railroad Situation (Review of the political bearings of the railroad situation, especially as regards charter rights). Mfrs Rec-Aug. 21. 1200 w.

7715. Laboratory Tests of Brakeshoes (Reviews past work of M. C. B. committee, describes apparatus and manner of testing, and gives diagram of results). R R Gaz-Aug 21. 2800 w.

7718. Train Accidents in the United States (Classified review of July accidents, with comment). R R Gaz-Aug. 21. 2700 w.

7719. The Heilmann Locomotive (A brief descriptive account of the locomotive and the experimental results attained with it in France. It is to be tried in this country). R R Gaz-Aug. 21. 900 w.

7721. Sand Tower, Chicago & Northwestern Railway (Brief description, with drawings). Ry Rev-Aug. 22. 700 w.

7722. Railway Receiverships and Reorganizations (Abstract of President Moorfield Story's address before the American Bar Assn. Methods at present in vogue. A statute designed to correct some of the evils in this connection was recently enacted in Kentucky and formed the text of the speaker's remarks). Ry Rev-Aug. 22. 1400 w.

*7736. Mechanical Haulage. J. Sturgeon (Read before the Tramway Inst. of Gt. Britain and Ireland. A discussion of traction by adhesion and by haulage, strongly favoring cable as against electric traction). Eng, Lond-Aug. 14. Serial. 1st part. 2700 w.

7755. Rack Railways (A review of some of the principal rack railways of the world, with illustrations of distinctive features of the line and equipment). Sci Am Sup-Aug. 22. 2000 w.

7843. Railroad Statistics of the United States (Abstract of statistics from advance sheets of Poor's Manual for 1896). R R Gaz-Aug. 28. 600 w.

7862. Labor Organization a Detriment to the Railroad Employé. William Gibson (Abstract of address before the Central Assn. of R. R. Officers. Enumerates some of the features of railroad labor organization which appear to be a disadvantage to the employé). Ry Mas Mech-Aug. 2500 w.

*7909. Notes from Argentine Republic. Ai Dolf (The notes of chief importance are upon the use of petroleum fuel). Loc Engng-Sept. 1800 w.

*7910. Accident to the West Coast Racer (Descriptive and illustrated account of the Preston derailment). Loc Engng-Sept. 450 w.

*7914. Investigations of Train Resistances (Reviews discrepancies and opinions, formulæ and test-results). Loc Engng-Sept. 1700 w.

7925. English Railroad Prosperity (A review of the substantial basis for present prosperity of the English railroads). Bradstreet's-Aug. 29. 1100 w.

*7930. The Regent's Canal, City, and Dock Railway (Describes past and present status and prospects of a London partial "belt road"). Eng, Lond-Aug. 21. 800 w.

*7931. With the West Coast "Flyer." Charles Rous-Marten (Detailed descriptive account of a typical run on an English express). Eng, Lond-Aug. 21. 1700 w.

†7956. Organization and Operating Methods of the Metropolitan Street Railway Company of New York (A general review of the operating system illustrated by map and charts). St Ry Jour-Sept. 4500 w.

8013 —$1. The Union Pacific Railway. J. P. Davis (Historical review with discussion of the financial and political aspects of the past, present and future relations of the railroad to the state). An of Am Acad-Sept. 12500 w.

*8042. Light Railways and Motor-Cars. R. H. Rew (A discussion of the importance and relations of light railways to agriculture, with comment on continental experience and practice). Ind & Ir-Aug. 28. Serial. 1st part. 2000 w.

SCIENTIFIC MISCELLANY

Sailing Flight.

THE most expert aeronaut in sailing flight, the late Herr Lilienthal, did not, so far as we are aware, support the theory that soaring birds are able to rise by upward currents of air, availing themselves of these currents at frequent intervals to maintain themselves on the wing for hours without apparent muscular effort. On the other hand, Mr. Maxim and others hold that these currents sufficiently account for the facts of soaring flight, assuming that, where soaring birds remain long in the air, such currents are always present at frequent and short intervals, and that, when birds float through one of them, they receive an upward impulse that sustains them till they pass into another. Mr. Maxim is well enough versed in the laws that govern the circulation of fluids to understand that, in an ocean of either water or air, currents in any direction imply counter-currents of equal energy in an opposite direction. So, alternately passing through upward and downward currents, soaring birds must be assumed to have some means of rendering the upward currents available and avoiding the effects of the downward currents; otherwise the theory fails. This power of adaptation is supposed by some to lie in the wing structure, which engages the upper currents of air more strongly than downward currents.

We have always questioned this explanation of soaring flight. Now, to *Nature* (August 6) a Mr. S. E. Peal of Sibsagar, Asam, has sent a very interesting letter, which confirms preëxisting doubts that the soaring of birds can be satisfactorily explained on the assumptions named. For the existence of alternate upward and downward currents within short distances on all occasions is a pure assumption, and the theory that wing structure accounts for all the difference in the effects of the two kinds of currents is also pure assumption, as yet unsupported by observed facts.

The soaring birds of Asam are the cyrus, the pelican, the vulture, the adjutant, etc., and the weight of the cyrus or of the pelican is frequently twenty pounds. Mr. Peal asserts that, when the northwest wind is blowing, the absence of the alternate upward and downward currents is distinctly proved by the steady horizontal movement of cotton tufts floating in the wind, and that, through a powerful telescope, he has at a long lateral distance watched, for hours, these heavy birds and the cotton tufts without the slightest indication of the assumed currents. The birds, he asserts, rise in a spiral course to the height of from one thousand to three thousand feet. After rising above surface eddies, their wings are rigidly extended, and only slight movements of their tails are now and then perceptible. He says (after an explanation of the position of the wings with reference to the body of the birds, and the position of the primary feathers with reference to the wings): "There is an entire absence of the mental and physical alertness and agility which would be constantly needed if these birds depended on inequalities of wind pressure and equally sudden and invisible up gusts to save themselves from falling." Mr. Peal anticipated in his letter the very accident by which Herr Lilienthal recently lost his life. He says:

"Herr Lilienthal is probably on the right trail. I see he desires to turn and meet the breeze; but in this movement, I fancy, the upper central aeroplane—so high above the center of gravity—will turn him over in a strong wind. In the bird's case (when turning) there is very obviously strong centripetal counter pressure, and great speed, quite sixty miles an hour, I should suppose, at end of the leeward lap. . . . The lifting is mainly done when it turns and meets the wind, and speed is slowed down, and the overturning is prevented, when the wings are laterally presented to the wind, by the great *lateral* expanse. As there is none of this latter, in

the centrally superposed plane machine the bird's great lateral steadiness is structurally absent.

"Soaring machines may be of two types: A, those *containing* their own power; and B, those deriving it from the surroundings only. There is no screw in the stern of the 'Bov Tokla,' as he wheels round and round close over me, as I sit hidden in a tuft of grass on the wide plain. Rising to windward, he circles over me at two hundred feet or so, and with binoculars, or even without, I can see each feather, and hear the loud noise they make; there is never a move, except a little in the tail, yet lap by lap the bird steadily rises, and as steadily, if slowly, gets a drift to leeward. I do not suppose the bird can soar without expenditure of energy; all I desire to point out is that upward air currents do not lift and sustain it; also that the lifting is seen to be applied to the primary wing feathers almost entirely, and in a way which shows the lift is due to lateral translation. Tie a primary at the end of a long light stick, and, on whirling it, the effect is obvious."

The Plague of City Noises.

J. H. GIRDNER, M. D., in *North American Review* for September, discusses a question of great interest to dwellers in cities. The physiological and pathological effects of the din that strikes so confusingly and tiresomely upon the ears of visitors from quiet rural villages and farms —effects that undoubtedly impress more or less even those who are unconscious of them—are set forth without much resort to medical technology, and in very interesting form.

For instance, who outside of the medical profession suspects, until authoritatively told, that their failing nervous energy is in large measure due to strain upon the system in the act of hearing. They go to the country for rest. For days afterward they feel like sleeping. The confused babel of sound they have left behind is a foe to sound sleep, and they have found a place where their nature and their need, no longer resisted, invite repose. When "well rested out," they cease to feel sleepy, except in the hours of habitual slumber. This is not alone true of such as work hard with brain or hand. Those who live in luxury have similar experiences. Who in the great city, watching by a life trembling in the balance where sleep, natural sleep (not forced by drugs), is the one thing sought and prayed for, —as the family doctor says, "the most sovereign remedy, but one that is not to be had from pharmacists,"—who has not at some time felt the unnecessary noises in the streets, penetrating the sick room, almost as they would feel blows or dagger-thrusts. Will the noise never stop? By and by, as midnight approaches, the streets become comparatively quiet. The weary, pained eyelids droop, and the delicious saving slumber settles down upon them, when suddenly the distant rumble of some ponderous truck is heard, its noise increasing as it comes nearer, till, crashing unmercifully by, the shock of sound drives away sleep, and the pain-racked sufferer again moans and tosses in anguish.

That a large part of the noise of cities is needless goes without saying. What use does the jangling of bells subserve? Who is benefitted by the cries and horns of street pedlers? Then there are the steam whistles and striking clocks; the barking of dogs; the caterwauling of feline prowlers; the periodical torture of exploding powder-crackers, torpedoes, pistols, and fireworks. All these are arraigned by Dr. Girdner as unnecessary and mischievous. Even the noise of vehicles could be reduced almost to nothing by asphalt pavements and the abolition of the loose manhole cover, of which Dr. Girder says that he knows of no single source of noise so annoying, especially to the sick.

One of "the worst brain-bruising assaults" is the din caused by truck-loads of iron rails, girders, etc., which might easily be avoided by placing pieces of old burlaps between the jarring surfaces.

"The cartman who drives through a street with the body of the cart banging the shafts at every stride of the horse ought to be stopped by the police and made to fasten the body firmly."

A very practical suggestion is made for

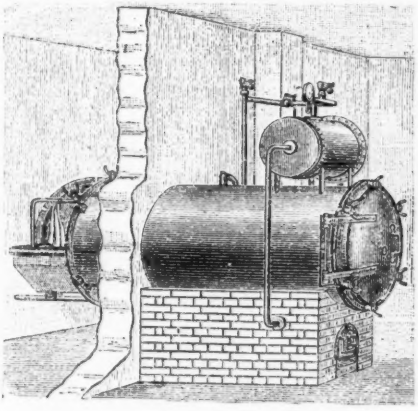
the organization of a society in New York ("Society for the Prevention of Noise" is formulated as an appropriate name for it), to replace the fitful protests of the public press by concerted effort for reform.

"It should have a charter and certain powers and responsibilities conferred upon it by the legislature. It should be modelled somewhat after the pattern of the Society for the Prevention of Cruelty to Animals, or the Gerry Society. It should make a study of the noises of the city, and through its own powers, and by advice and coöperation with the various city departments, suppress such noises as are unnecessary, and reduce those that are necessary to a minimum."

We have no doubt that such a society can be organized, that it could effect the needed reforms, and that it would receive the support of the medical faculty, and the approval and coöperation of the best citizens. The success of such a society in New York would set the pace for similar societies in other cities equally in need of relief from the burden of needless noise.

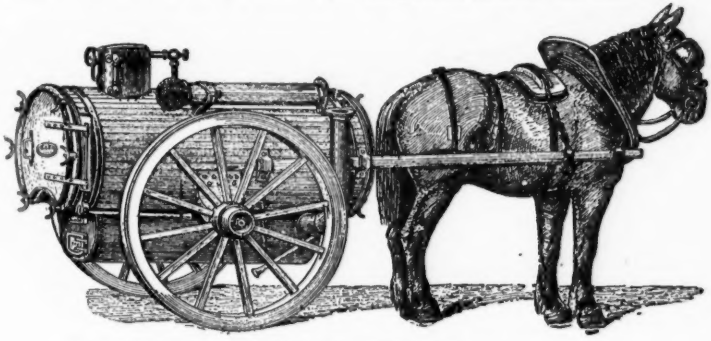
Beck's Disinfectors.

WITH the advance in sanitary science, it has become known that modes of disinfection formerly relied upon do not justify confidence, and appliances for still more thorough work have come into demand. Moist heat is far more powerful than dry heat as a germicide. This was demonstrated by Tyndall in the famous controversy upon spontaneous generation in which he took a prominent part. As a result, steam disinfectors are leading the van now, and one designed by a Copenhagen engineer—Mr. A. B. Beck—combines with cheapness a degree of efficiency that leaves hardly anything to be desired. It is also very convenient in use, and capable of being mounted as a stationary or a portable appliance. We herewith illustrate both arrangements, reproducing the cuts and condensing the descriptive text from *The Sanitary Record* (Aug. 14).



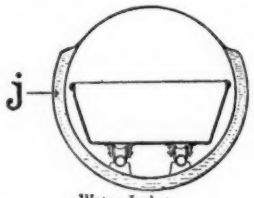
STATIONARY DISINFECTOR.

The original device of Mr. Beck had some disadvantages which are removed in the present form of the disinfector. The essential features of the apparatus are the admission of steam under a moderate pressure into the cylindrical chambers in which



PORTABLE DISINFECTOR.

the articles to be disinfected are suspended, and the subsequent condensation of the steam by a shower of cold water discharged over a screen which, fixed parallel with the upper half of the chamber, protects the articles beneath it from the contact of the water, the latter being run off by a drain in the floor. In the original arrangement the articles were removed to a separate drying-room or chamber heated



Water Jacket.

by a steam coil, where the drying was effected. About a year ago this disinfector was exhibited at the Liverpool meeting of the Sanitary Institute and there experimented with, and it was shown to be competent to destroy all deleterious germs —even spores of anthrax—in fifteen minutes.

The improvements consist, first, in an arrangement which dispenses with this drying closet, and permits of the entire process being carried out in the disinfector itself. This is now made with a water jacket embracing the lower two-thirds of its circumference, which is partially filled and closed by a screw plug. When the chamber is charged with steam, the heat is transmitted to the water, which, by the end of half an hour, has been raised nearly to the boiling-point. The articles having been exposed to the heat as long as is deemed sufficient for complete disinfection, the steam is shut off, and the cold shower turned on, condensing the vapor contained in the chamber; after which the door is partly opened, allowing the moisture in the clothes or bedding to escape as fast as it evaporates, and, by the time that the water in the jacket and the air in the chamber have cooled down to the temperature of the surrounding atmosphere, the articles disinfected may be actually drier, as shown by a small, but appreciable, loss of weight, than they were when first received at the station.

The other improvement is the entire separation of the furnace from the apparatus, no part of which is now exposed to the action of the fire. An ordinary saddle boiler is set in masonry over the furnace, and connected by an ascending and a return pipe with a steam drum fixed above the chamber, and communicating with it by a short pipe fitted with a stop-cock, and opening into the roof of the chamber above the screen, as does also that which admits the cold shower, thus avoiding direct contact alike of the steam jet and cold douche with the articles suspended beneath. The boiler, which is the only part of the apparatus likely to require repair, can thus be renewed as often as is necessary by an ordinary workman, without disturbing the rest of the arrangements. These improvements are also introduced into the portable disinfectors, which in their general appearance are not unlike an agricultural steam engine, the only difference between these and the stationary apparatus being that the furnace and boiler are set in an iron frame instead of in brick.

The Great Sea Waves in Japan.

In June the world was startled and horrified by the news that seventy miles of the Japanese coast had been inundated by one of those great sea waves to which the sea is subject in the region of the Japanese group of islands, and that thirty thousand lives were lost in the catastrophe. What is the origin of these waves? Scientific men have assigned causes which seem to be sufficient to account for them, but no one of these has been absolutely verified, and they are, as yet, purely speculative. Seismography has been making progress, however, and the indications are strong that the destructive wave referred to had its origin in a seismic disturbance at the bottom of the sea.

In an editorial upon this subject, in *Engineering* (Aug. 7), it is said that for the best part of a month the British public was led by mails and telegrams to believe that the catastrophe occurred on June 17.

"On that day, however, microseismographs and equivalent instruments were at rest, and, therefore, if the telegrams were correct, a terrible oceanic disturbance which must have been perceptible in all parts of the Pacific ocean had been created without any accompanying movement of the earth's crust. On June 15 Professor Vincincenti, in Italy, noted the commencement of the disturbance, in which there were several maxima which culminated in Japan time at about nine o'clock on the following morning. A similar commencement was recorded at Shide in the Isle of Wight, but, as at a later hour this instrument was dismantled for adjustment,.... a complete record was not obtained.

"These facts so impressed those who were acquainted with the working of such apparatus and its capability of recording disturbances, even if their origin were at their antipodes, that notes were published in *Nature* and the *Times* suggesting that, for unknown reasons, it was likely that our telegraphic information was incorrect. This surmise that Reuter and our newspapers were in error, and that the seismographs were not only right to the minute and the hour, but gave us information as to the number, relative intensity, and the times of occurrence of the successive efforts which created so much destruction, is now an established fact."

Here we have very strong evidence that waves of this character are due to disturbances of the earth's crust.

Our contemporary says that these waves which have from time to time visited Japan have "one and all taken place upon the eastern coast, where the land slopes rapidly downwards beneath the deep Pacific, and where there are soundings of over 4,600 fathoms. The magnitudes of the waves have depended upon the distance of their origin from the shore on which they impinged, on the sizes of the displacements by which they were produced, and on the contour of the coast which was invaded. Some may have coincided with the regular lunar tides.

"The sea waves of 1868 and 1877, originating as they did at a distance approaching 9,000 miles off the South American coast, took nearly twenty-four hours before they reached the coast of Japan, where they rose and fell every ten or thirty minutes, like rapidly-recurring tides. The inhabitants on the coast, naturally alarmed at such a phenomenon, and not knowing the height the waters might eventually attain, fled with their *penates* to higher ground. Although in many places situated near the heads of estuaries with broad openings the water quickly rose and fell through heights of from six feet to ten feet, nothing of the nature of a wave was visible upon the horizon. Nor would such waves, although they were travelling with velocities of from three hundred to four hundred miles per hour,—a rate dependent upon the average depth of the ocean in which they were propagated,—be noticeable upon ships on the open sea. That this might well be so is easily recognizable when we state that, although they might be ten feet or so in height, their length, as measured from crest to crest, approached two hundred miles. These same waves, nearer to their origin on the South American coast, as with the waves of 1896 upon the Japan coast, as they rushed in upon the coast, piled up on shallow shores and the heads of bays, until they burst as avalanches of water from thirty feet to eighty feet in height, to rush inland for a distance of one or two miles, carrying all before them. Just as a steamer going up a river withdraws the water from either shore to form the wave it leaves in its wake, in a similar manner an earthquake wave warns the inhabitants on a shore of its approach by a rapid recession of the water. In Japan, when this recession took place, it was dark, and therefore only seen by a few, some of whom sought refuge on high ground to look back, first, on a bare shore, which, they say, emitted a curious phosphorescent light, and then on the white-capped dusky mass, which swept away all before it. Out at sea the waves were too long to be observed by fishermen, who, in the morning, put back to their harbors to find the sites of their villages represented by masses of sodden débris."

Nitragin.

AFTER a brief summary of the important results of Pasteur's brilliant investigations in the various food-producing industries and in the manufacture of wine and beer, C. M. Aikman, in *The Contemporary Review* for August, discourses upon what is likely to prove one of the most remarkable of these results,—the inoculation of the soil with pure cultures of bacteria, with the object of increasing its productiveness. The general name "nitragin" has been given to these cultures.

Pasteur having shown that all decomposition of organic matter is due to the action of micro-organic life, it is a logical sequence that, as the growth of living plants largely depends upon the products of such decomposition, the action of such living micro-organisms as aid in this work may be brought under control, in a manner wholly analogous to the methods now employed in the making of wines, cider, beer, butter, etc. The supply of the pure cultures necessary has been undertaken by a large German chemical manufacturing establishment, and this fairly inaugurates what is judged by competent men to be an important advance in the science and practice of agriculture.

Of all substances resulting from decomposition of organic materials, nitrogen is the most important of plant foods. Its supply in a form suitable for assimilation by plants has long been recognized as essential to successful agriculture. Although the air contains a large quantity (seventy-three per cent. of its volume) of nitrogen, atmospheric nitrogen is in a form unfit for the food of most plants. Only the leguminous plants can take nitrogen directly from air; clover, peas, beans, etc., are among these plants. In decaying, these plants give off their nitrogen in a form suitable for the food of other plants. The practice of sowing clover and ploughing under the crop as a preparation for a crop of another kind was long practised before the reason for the effect was understood. Recent investigation of the nodules on the roots of leguminous plants has discovered the fact that these nodules are the habitats of micro-organisms which effect the desired fixation of nitrogen, though how this is done yet remains a mystery.

"Living at first at the expense of the plant, as parasites, they gradually become passive, and the cells then become filled with bacteroids or bacterium-like bodies." When this period is reached, the plant absorbs the contents of the nodules. Whether there is only one kind, or a number of kinds, of bacteria that thus act is not yet known.

"The early experiments on a practical scale were made by inoculating soils, on which leguminous crops had been found by practice not to do well, with soil from fields containing the nitrogen-fixing bacteria in large numbers. To effect this satisfactorily it was found that no less a quantity than sixteen cwts. of soil had to be used per acre. This method, besides proving cumbersome, is not free from other objections, since organisms other than the nitrogen-fixing ones—organisms which may exert a distinctly unfavorable action on plant growth, as well as induce fungoid diseases or parasitic growths—may be present in the soil thus applied. Professor Nobbe consequently set himself to obtain pure cultures of the fixing bacteria by the usual bacteriological methods. Inasmuch as the different leguminous crops require, as we have already explained, either separate organisms or else different modifications of the same organism, Professor Nobbe has prepared a large number of pure cultivations suited for the commoner leguminous crops grown. These cultures are preserved in glass bottles containing *agar-gelatine*,—a commonly-used developing medium,—and are of eight to ten ounces' capacity. They have to be kept from the influence of the light, and care must be taken not to expose them to a temperature above 98° F. Inoculation of a soil with these cultures, on a practical scale, may be effected in either of two ways. First, the seed of the crop it is desired to inoculate may be inoculated before it is sown. This is effected by making a watery solution of the pure cultivation, immersing the seed in it, and subsequently drying it; or, secondly, it may be effected by inoculating a quan-

tity of fine sand, or earth, in the same way, and then spreading it over the field, and subsequently working it into the soil to a depth of about three inches.

"Naturally, a point of considerable interest is the economic question of the cost of such treatment. It is interesting to learn that this is extremely moderate, as the expense of inoculating a field in this way amounts to the very modest sum of five shillings per acre. This cannot be regarded as expensive, and contrasts favorably with the expense of nitrogenous fertilizers.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

†7576. Nitragin: An Important Advance In the Science of Agriculture. C. M. Aikman (A description of the latest application of the principle of inoculation in agriculture—the inoculation of the soil with pure cultures of bacteria for promoting plant growth). Contemporary Rev-Aug. 2000 w.

7587. Deleterious Effects of X-Rays on the Human Body (Editorial account of physical effects upon H. D. Hawks, who has been giving exhibitions with an unusually powerful X ray outfit). Elec Rev-Aug 12. 450 w.

7588. Roentgen Rays or Streams. Nikola Tesla (A summary of observations previously made, with arguments to show that these rays consist of streams of matter in some primary condition). Elec Rev-Aug. 12. 2500 w.

7595. A New Light for Photographers. C. F. Townsend (Illustrated description of the new light "*La Lampe Caton*"). Sci Am-Aug. 15. 1100 w.

7596. The Sardine Fishing Industry in New Brunswick. Prof. Prince (From the report of the Department of Marine and Fisheries. An interesting description of an important industry). Sci Am Sup-Aug 15. 2500 w.

7597. Industrial and Trade Schools in Germany (Digest of report by Mr. L. R. Klemm, of the Bureau of Education, Washington, D. C). Sci Am Sup-Aug. 15. 2400 w.

7598. $250 Prize Essay Composition—The Progress of Invention During the Past Fifty Years. Fourth Prize, won by (Semper Fidelis) Gardner D. Hiscox (An excellent historical review). Sci Am Sup-Aug. 15. 3200 w.

†7615. India as a Field for Investment.—Tea (The purpose of this article is to show that with modern improvements in appliances for cultivating, harvesting and curing tea, the East India tea industry offers a remunerative investment to those who may wish to engage in it). Ind & East Eng-Aug. 1. 2800 w.

*7657. The Great Sea Waves in Japan (Editorial discussion of the seismic disturbance which caused the inundation of the northern Japanese coast in June, and the resources of engineering science which may help to avert the great destruction caused by such disturbances). Engng-Aug. 7. 2500 w.

*7660. New Zealand Timber (Editorial, calling for efforts to stimulate trade between Britain and distant parts of the empire, and calling attention to New Zealand timber as a promising opening for such trade, with particulars relating to kinds and value of timber available). Engng-Aug. 7. 1300 w.

*7682. The Röntgen Rays. J. J. Thomson (Abstract of the Rede lecture, given at the University of Cambridge. A general dissertation upon the facts and current theories of the Röntgen rays, and their probable future as a means of physical investigation). Elect'n-Aug. 14. 2800 w.

7717. Past and Present Tendencies in Engineering Education. Mansfield Merriman (Presidential address before the Society for the Promotion of Engineering Education. An elaborate article touching upon nearly all the aspects of the question). R R Gaz-Aug. 21. 3200 w.

7729. Practical Solution of Fourth Degree Equations. George B. Grant (The process described is one of simple substitution in formulæ involving much work which however is of a simple character). Am Mach-Aug. 20. 600 w.

7753. Nansen's Polar Expedition (Interesting outline of the expedition from beginning to the arrival of the explorer at Vardoe. Map). Sci Am-Aug. 22. 1200 w.

7800. The Absolute Zero (Explanation of the term, how it is determined, etc., with diagrams). Am Elect'n-Aug. 500 w.

7805. Use of Photography in Data Collections. Reginald A. Fessenden (Illustrated description of apparatus and rapid method for the photographic copying of indexed data from books, pamphlets and periodicals, with list of material needed). Elec Wld-Aug. 22. 3000 w.

†7876. Optical Mineralogy. Lea McI. Luquer (Treats of a system of microscopical examination for the accurate determination of rocks). Sch of Mines Quar-July. 10000 w.

†7882. The Plague of City Noises. J. H. Girdner (The deleterious effect of confused noises upon sight and hearing, the needlessness of many city noises, and means for abating them are considered). N Amer Rev-Sept. 2800 w.

†7883. An Industrial Opportunity for America. E. Sowers (The opportunity discussed is the manufacture of beet sugar, and the history and progress of this industry in other lands are made use of in an argument urging the extension of beet culture to parts of the United States named as favorable). N Amer Rev-Sept. 3300 w.

*7886. Coffee Growing in Peru (Illustrated

We supply copies of these articles. See introductory.

general description of the industry, as conducted in the valleys of Chanchamayo and Perené). Engng-Aug. 21. 3000 w.

7905. A Completed Chapter in the History of the Atomic Theory. Edward W. Morley (Address by the retiring Pres. of the Am. Assn. for the Advancement of Science. Prout's hypothesis made in 1815, and accepted as probable by some eminent chemists,—that the atomic weights of other elements were probably divisible by the atomic weight of hydrogen taken as unity, is held to be so completely disproved by modern research that it must be abandoned. The proofs of its falsity are given and other lines for the study of atoms are suggested). Science-Aug. 28. 8000 w.

†7906. Bacteria and Carbonated Waters. G. C. Frankland (A statement of discrepancies in the results and conclusions of different observers, upon the hygienic importance of gaseous aeration of water from a bacterial point of view, is followed by a statement of the behavior of pathogenic bacteria in such water, upon which the results show much better agreement). Nature-Aug. 20. 1600 w.

*7907. A Research on the Liquefaction of Helium (Translated from the original paper by Prof. K. Olszewski, in the *Bulletin de l'Académie des Sciences des Cracovie* for June, 1896, "Ein Versuch, das Helium zu verflünigen," by Morris Travers Description of apparatus, method and results). Nature-Aug. 20. 1800 w.

*7908. On Periodicity of Good and Bad Seasons. H. C. Russell (Abridged from a paper read before the Royal Society of New South South Wales. Results of systematic observation showing periodicity in the weather, floods and droughts). Nature-Aug. 20. 2800 w.

*7937. The Nomenclature of Asphalt and Mineral Bitumen or Pitch. Leon Malo (The distinctions between asphalt and bitumen are set forth and the nomenclature published in the *Annales des Ponts et Chaussées*, in 1861, is confirmed). Munic Engng-Sept. 1500 w.

7970. Machine for Solving Numerical Equations. George B. Grant (Illustrated description which gives rough approximations to roots of numerical equations, and competent to give the integral figures of roots of the general equation of the fourth degree). Am Mach-Sept. 3. 1100 w.

7983. Open Hearth Furnaces in Glass Works. From *La Nature* (Illustrated description). Sci Am Sup-Sept. 5. 1400 w.

7986. On the Comparison of Low and High Vacuum Electrical and Radiant Matter Phenomena with the Aurora, the Solar Corona, and Comets. Wallace Gould Levison (Abstract of a note read before the New York Academy of Sciences. Auroral phenomena explained; comets regarded as aggregations of radiant matter. The solar corona is also referred to the same category). Sci Am-Sept. 5. 1800 w.

†7992. On the Regular or Specular Reflection of the Röntgen Rays from Polished Metallic Surfaces. O. N. Rood (Results with different materials and different forms of reflectors). Am Jour of Sci-Sept. 3200 w.

†8022. Estimation of Thoria. Chemical Analysis of Monazite Sand. Charles Glaser (An account of preliminary experiments in a general investigation relating to the best methods of estimating the percentage of thoria, recently become of high commercial importance). Jour Am Chem Soc-Sept. 3300 w.

†8062. Production of Coffee in Mexico (A full description of the industry in reply to numbers of letters of inquiry). Cons Repts-Sept. 10800 w.

*8069. The Eclipse of the Sun. J. Norman Lockyer (An account of the expedition to Kiō Island, to observe the last solar eclipse, with its results. Illustrated). Nature-Aug. 27. Serial. 1st part. 4400 w.

*8070. Large Explosions and Their Radii of Danger. J. T. Bucknill (This investigation has for its object the affording of data for legislation directed to the safeguard of property from danger caused by the traffic in and storage of explosives in large quantities). Eng-Aug. 28. Serial. 1st part. 2200 w.

*8071. The Engineering Department of the Yorkshire College, Leeds (Illustrated description). Engng-Aug. 28. 2000 w.

*8075. Timbers in the Straits Settlements. Henry J. Child (Paper presented to the Assn. of Surveyors of H. M. Service. A very compact summary of the names, qualities, and uses of different kinds of timber. Most of the timbers named are entirely unfamiliar to the American people). Engng-Aug. 28. 1400 w.

8083. The Transmutation of Silver into Gold (Correspondence on this subject between the editor of the Eng. & Min. Jour. and Dr. Stephan H. Emmons, who was announced in several N. Y. papers as having discovered a chemical process by which silver could be transmuted into gold). Eng & Min Jour-Sept. 5. 3500 w.

†8102. Origin and Age of the Laurentian Lakes and of Niagara Falls. Warren Upham (Presented before the Geol. Soc. of Amer. and Section E. of the Am. Assn. for the Advancement of Science. The preglacial condition of the St. Lawrence basin, changes bringing on the ice age, recession of the ice-sheet, glacial lakes, beginning of Niagara River, variations of the volume, duration, &c). Am Geol-Sept. 3000 w.

8112. The Andrée Polar Expedition (Illustrated description of Andrée's balloon, and balloon house, in Spitzbergen). Sci Am Sup-Sept. 12. 1000 w.

†8119. The Philosophy of the Pneumatic Tire. Reprint from the *N. Y. Sun* (An interesting explanation of the action of pneumatic tires on various kinds of roads, with comparison with the cushion tire). Ind Rub Wld-Sept. 10. 2400 w.

†8120. The Production and Use of Dental Vulcanite. W. Storer How (Directions for making a fine, strong, solid, odorless vulcanite denture). Ind Rub Wld-Sept. 10. 1000 w.

†8121. American and Foreign Rubber Facts in Figures (Statistics of interest to the rubber industry, with editorial comment). Ind Rub Wld-Sept. 10. 1500 w.

COMMENT & CRITICISM

That $15,000 Experimental Engine.

IN my article on "Quackery in Engineering Education" I advanced certain views in regard to that "$15,000 experimental steam engine." Some statements questioning the soundness of these views have appeared in your pages; none of them, however, seem to have emanated from a steam engineer. As another of these machines was recently added to a college equipment, and no doubt the near future will witness new demands for funds to increase their number, it will not be inopportune to state why I consider such an investment unwise.

As a piece of laboratory apparatus a steam engine is of value for but two things: (1) to illustrate principles and to teach correct methods of adjusting, operating, testing, etc.; (2) to conduct original researches. As to the first, everything of consequence can be taught by a competent man from an engine costing not more than $700; in fact, a considerable portion of the work can be better taught from a small than from a large engine. A small machine running at three hundred and fifty revolutions is far more difficult to indicate than any large engine; hence it affords better practice. Similarly, all essential operations on valve-setting, testing, etc., can be learned just as well from a 10 × 24 Corliss as from the largest size built, and more quickly at that, as the student wastes no time on a lot of pieces heavy enough to impede his work, but not warranting an outlay sufficient to provide ample mechanical means for handling them. In regard to care and management a large engine would certainly afford valuable experience that could not be got from a small one. It is questionable whether in a school such experience can be got to an extent worth considering; but, if it can, this fact proves nothing for a single one of these triple-expansion experimental engines. All within my knowledge are of the Corliss type, hence slow speed; some were designed to develop only 100 h. p., others 150, and the largest of them has cylinders 9, 16, and 24 inches, by 30 inches stroke. This machine is entirely too small to give the kind of experience just mentioned, and does not require for its management as much vigilance and knowledge as would be demanded by a smaller engine running at a high speed. This is too well known to every steam engineer to need further discussion.

Apart from show, the real purpose of these machines is found in that word "experimental." Experiments are valuable for two purposes only: (1) to illustrate known facts; (2) to discover new ones. The former can, sufficiently for all purposes of instruction, be achieved on a single-cylinder engine. The latter, then, is the real object. One school says: "This engine is designed to run single, compound, triple, and will be provided with brakes, condensers, etc., whereby *exhaustive experimental tests may be made.*" Another states: "The arrangement of the accessory apparatus is sufficiently complete to permit *a close study of all the finer problems affecting the performances of steam engines.*" I respectfully dissent from these views, because none of these engines reflect conditions found in practice; hence tests on them fail to furnish data that can safely be used in practical problems, except *perhaps* in a limited number of cases. I cannot recall a single case in practice where the installing of a triple-expansion Corliss engine equal to the largest of these school machines would not be a serious mistake. Nor will it help matters to say that small triple-expansion engines are used in marine work, and, very rarely, on land, since all these are high-speed engines, working under heavy pressure, and of a design

wholly different from that of the engines under discussion. To apply to them, without further experimentation, any conclusions drawn from tests on these Corliss engines would be a palpable error of judgment. It therefore seems that, from the very design of these experimental engines, nearly all results got from them will be *sui generis;* hence of little practical value. Nor can these machines be of any great use in the "attempt to teach the theory and practice of compounding, jacketing, and *all the many other details* entering into the economy and management of modern large power units," since they themselves are neither large power units or a form which any engineer would use. To talk of teaching the "theory and practice of jacketing" by means of such a machine is ludicrous. The engineering world is anxiously looking for the man who can do this on any engine. The status of the steam jacket is by no means settled, nor can any number of experiments on such engines, or dozens of regular working machines, furnish sufficient data to settle it, as is clearly shown by the "Report of the Research Committee of the Institution of Mechanical Engineers on the Value of the Steam Jacket." (Oct. 26, 1892.)

After laboring nearly six years, this committee, composed of the foremost English experts, "do not appear to have arrived at any very definite conclusions." Comment is unnecessary.

I therefore fail to see what really valuable results can be got from experimental engines of a size and design used by nobody outside of technical schools. I believe that, up to the day they land in the scrap-pile, they will contribute far less real information than can be got from a few careful and exhaustive tests on engines of a size and type in general use. That they are excellent for the spectacular I can readily see, but I still consider it an educational and business mistake to divert from better uses the $9,000 needed to instal that "$15,000 experimental steam-engine."

EDGAR KIDWELL.

Michigan Mining School, Houghton, Mich., September, 1896.

Are British Railroads Good Investments?

MAY I ask a little space to make a few remarks upon the reply of Mr. W. J. Stevens (in your August number) to my article on British railroads as investments (in your May number), as it is evident that Mr. Stevens has no treally touched the principal point of my criticism.

My proposition was that British railroads, at the prices for their stocks which ruled in March last, when my article was written, were not good investments. I showed that they were being bought to yield (on the basis of the 1895 dividends) about 3¼ to 3⅜ per cent. on the ordinary stocks, 2¾ per cent. on the preferred stocks, and 2½ to 2¾ per cent. on the debenture stocks. I argued from this that, with so low rates of return on the investment, there must be great security of yield, and at least a reasonable prospect of increase of yield; and I asked whether this security existed in the case of British roads. In endeavoring to answer this question, I showed that, between 1885 and 1894, capitalization increased faster than did mileage or net earnings, and that the rate of return on capital had consequently decreased. I showed further that in this period operating expenses had absorbed almost all the increase in gross earnings, and that the increase in operating expenses appeared to be almost entirely in items other than those of "maintenance." In point of fact, wages, rates, and taxes accounted for the entire increase. I pointed out that enormous additions to capital account, which did not produce a corresponding return of net revenue when coincident with relatively decreased expenditures, naturally led to the question whether "new equipment" and "improvements" were not taking the place that should have been filled by "maintenance of equipment" and "maintenance of way" expenditures, charged to operating cost.

On that I rested my case against these roads as investments, on the ground that the time must come some day when "construction" and the issue of new capital must cease, and then operating expenses

must increase, to the detriment of dividends.

Mr. Stevens's reply states the case as follows: Since 1894 (the year chosen by me for comparison as the latest for which board of trade statistics were available) there has been a great recovery in British railroad earnings and a general increase in dividends, which bids fair to continue in progress. Furthermore, that, after allowing for nominal additions to capital from conversions and so on, the return on actual capital invested would have been over four per cent. in 1894. Furthermore, that, although the increased main line mileage in ten years is only 1,739, there has been considerable increase in third and fourth track mileage. Furthermore, that the railroads are able to borrow fresh capital now at 3 per cent. or less, and consequently do not require to maintain the same "overhead return" that they did. Furthermore, that the increase in wages, rates, and taxes has now been arrested, that the decrease in cost of materials in "maintenance of way and equipment" is due to lower prices for supplies, and that the increase in wages of shop and track employees has been relatively much smaller than that of engineers, switchmen, conductors, and other employees in the transportation departments. Furthermore, that the scarcity of investments of a high class leaves investors nothing else to buy but "home rails," which are especially attractive in view of the increasing earnings, good management, freedom from competition of a reckless kind, and the fact that capital largely represents money paid in in excess of the nominal amount of the stock. This is a fair statement of Mr. Stevens's case.

I am not conscious of having omitted any of his contention. It will be at once noticed that this argument chiefly rests on the fact that there has been a general recovery in business in 1895 and since, which, he thinks, will continue, and of course during its continuance dividends will be maintained, and perhaps increased. As regards expenses, his claim is that wages, rates, and taxes have increased heavily, while cost of materials has decreased, except for fuel, and he endeavors to explain the absence of relative increase in maintenance expenditures on this ground.

In this he does not touch the main point of my criticism, which was that the tendency of capital expenditure to increase without a corresponding increase in "maintenance expenditures" or net earnings argued something wrong in the theory of management, and suggested that capital was doing the work of "maintenance" charges. I never suggested that British railroads would not have periods of prosperity again, when dividends would increase. I did say that they would some day have to face the permanent closing of "construction account" and permanent increase in expenses, and that for this reason they were not good investments at prices based on open "construction accounts" and very cheap money in a time of prosperity.

I have on this point a witness to produce, whose credibility and knowledge will not be disputed by Mr. Stevens. It is a little book dated 1896, entitled "Home Railways as Investments," by Mr. W. J. Stevens. I present the following extracts therefrom:

"Though among the large companies from half a million to a million is frequently spent upon this (*capital*) account during the six months, the fact is generally diminished by the chairman at the half-yearly meeting by a bare mention of the figures, while with the most minute details he wearies the shareholders with inconsequent remarks and figures relating to all the items of revenue. . . . . "

"The other weak point in the financial position of our railways is the rapid increase in capital. The theory upon which our railways work is to charge to revenue all that is necessary to keep the line up to its original standard of efficiency, and to charge practically every addition to its rolling stock and the cost of all improvements and extensions of their systems to capital accounts. . . . . It is obvious that such a theory, if not acted upon very strictly, may lead to serious abuses. Even to act up to it to the letter is hardly judicious in all circumstances, and this is

what most companies do. . . . . In fact, the question is not how little can be charged to capital but how much."

"Had a proper policy been pursued from the first, there is no doubt that the ordinary stocks would be in a much better position than they are, for fixed charges would have been very much lower than at present."

"The superiority of the London and Northwestern reflects itself in this important item (*capital outlay*), and, though it is more free with its capital expenditures than, taking all probabilities into account, could be wished, it is much more strict in its charges to capital account than most other companies. For years past it has charged nothing whatever to capital account in respect of law and parliamentary expenses, defraying all these out of revenue, contrary to the general practice." "Since 1889, though the (*Midland*) wagon stock has been continuously on the increase, the amount charged to revenue for the maintenance of that stock has declined year by year, until it is now £170,000 below the figures of 1889. . . . . Besides, if we go back to 1880, before the purchase of wagons began, it will be found that, on its then stock of over 32,000 wagons, it charged to revenue an average of about £5 per wagon for repairs and renewals. In 1895 the average charge was only a trifle more than half that,—*viz.*, £2,12s.0. It is more than likely that the Midland is, through a somewhat roundabout progress, deriving a considerable benefit to its revenue from the fact that large sums have been paid out of capital for the purchase of mineral wagons during recent years."

"One of the strongest points about the Northeastern is the excellent provision it makes out of revenue for the maintenance of its permanent way and repairs and renewals of its rolling-stock of all kinds."

"In the case of English railways it is very difficult to draw the line between what are revenue and what are capital wages, and the division in a great many cases where the circumstances are otherwise similar will depend a good deal upon the financial condition of each company. With an open capital account, the danger of directing revenue charges thereto, is an ever present one, and one of the very easiest possible methods of doing this is by making inadequate charges against revenue for the maintenance of the road and rolling-stock."

I could find more statements of the same kind in Mr. Stevens's book,—which, by the way, is an excellent manual for all interested in British railroads,—but the above are more than sufficient. Indeed, if I had had Mr. Stevens's book in my possession before I wrote the article in the May number, I should have felt obliged to credit Mr. Stevens with the whole argument. He is about the last man that I should have expected to dispute my contentions, for his book goes far to prove them up to the hilt.

"One more quotation, and I have done:

"No doubt there is a certain element of danger in the feature that low money rates have contributed to the declining yield and relatively high prices of home railway stocks generally. But, allowing for all contingencies in the direction of dearer money, there seems no doubt that the return on home railway stocks has been permanently reduced. Furthermore, there is the prospect that improving dividends will more than counteract the possible adverse influence on prices of dearer money rates. At the same time it is doubtful if ever before the market for home railway stocks was so liable to be influence by the course of events in the money market."

Bursts of prosperity may mask unprofitable expenditures of capital and insufficient charging of revenue for a time; cheap money may force investors and speculators into British railroad stocks at the high prices; there may be an almost inexhaustible supply of money yet to be expended on the railroads. These do not alter the facts, and sooner or later—and a rise in the value of money may bring it sooner than many think—the facts will show themselves. If they are as I suppose them to be, and as Mr. Stevens's book already shows them to be, there will be an end to capital expenditures, and a very appreciable rise in the rates of operating

expenses. With money worth three or four per cent., and with dividends below the present basis, where will investors at present prices in British railway stocks then be?

THOMAS F. WOODLOCK.

August, 1896.

Ashes as a Source of Municipal Revenue.

As the inventor and maker of bricks made from ashes, I desire to reply to your interesting article (p. 979, August number) upon the above subject.

My namesake (not a relative, and since deceased) some years ago brought out a "destructor" to cremate scavenging refuse, but achieved only partial success, two-thirds of the rubbish even then needing treatment.

In the face of this, why not deal with the whole of the material as collected, and turn it to advantage, instead of following the cumbersome, expensive, and wasteful system of destruction?

Briefly, the mode I employ is:

(1) Lime is scattered upon the refuse as soon as tipped, to prevent the exhalation of noxious smells.

(2) Everything is ground together with lime, excepting what can be profitably disposed of,—such as metals, leather, and rags.

(3) The resulting mixture is moulded into bricks and blocks.

Recently the subject has engaged the attention of the South Wales Institute of Engineers, in which body it was suggested that my samples should be tested to see what crushing strain they would bear.

This duty was readily and kindly undertaken by Professor Elliott of University College, Cardiff, who used the splendid testing machine at the Technical Schools there, with the result that a brick made two years ago gave a higher crushing record than many stones with which the professor had previously dealt. Bearing in mind the relative ages of the two substances, stone and my material,—thousands of years as against months, there can be no doubt whatever that, properly made and mixed, a good, salable article can be produced from what is now a costly bugbear to municipal authorities.

I may here remark that no burning is required whatever, the composition setting, like cement; and I use the bricks and blocks (the latter 9″×9″×12″), as soon as they will bear carriage, in houses which I am building.

Col. George E. Waring, Jr., is to be commended for bringing so important a subject under the notice of the municipal authorities of New York, but it appears to me that that gentleman, having started on the right road, has deviated from his course, and so missed the goal.

As to the value of ashes, I go with Col. Waring; but, when he states that the mixture of garbage makes ashes unfit for useful purposes, we part company. For instance, the component parts of vegetable matter generally are potash, water, and coloring matter. What objection, then, can there be to this material, when decomposed by lime? and so with fish, wherein is obtained a form of phosphate of lime.

In fact, the whole list of garbage can be regarded as so much useful matter, when in combination with lime.

Bricks made in America have utterly failed under the weather-test, while my bricks successfully withstand the weather; may not the failure of the former arise from the separation of the garbage from the ashes, thereby preventing the various chemical combinations from being set up?

To those who attach but slight importance to chemical changes, I would suggest that they make it a matter of inquiry why:

(1) Spontaneous combustion takes place in some ash-heaps; (2) Without spontaneous combustion in other ash-heaps, everything, barring ashes and precious metals, disappears.

JOHN T. FRYER.

Locksbrook Mills, Bath, August 24, 18

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Rose Polytechnic Institute, Terre Haute, Ind., U. S. A.=(a) General catalogue 1896. (b) Department of Engineering, course of study and faculty. (c) Department of Electrical Engineering, etc. (d) Department of Chemis ry, etc. (e) Department of Mechanical Engineering. Laboratory and shop outfits are described.

American Boiler Company, Chicago, Ill., U. S. A., and New York.=Catalogue of steam and hot-water heating apparatus, radiators, valves, pipe, fittings, etc , including the "Non-Drip automatic" radiator air valves, "Perfection" and "Royal."

L. Metesser, New Orleans, La., U. S. A.=(a) Pamphlet illustrating and describing the Cahill Vertical water-tube boiler. (b) Pamphlet illustrating and describing the Metesser gas producer-regenerative furnace for the consumption of low-grade fuels.

Mast, Foos & Co., Springfield, Ohio, U. S. A.=Latest catalogue and price lists of force-pumps, iron turbine wind engines, Columbia steel wind mills, steel wind mill derricks, etc., etc.

Patterson, Gottfried & Hunter, Limited, New York.=Catalogue and price lists of twist drills, reamers, taps, spring cotters, flat and riveted keys.

Otto Goetze, New York.=Pamphlet containing opinions of leading firms on manocitin as a rust preventive. Sent free on application.

Watertown Engine Co., Watertown, N. Y., U. S. A.=Leaflet illustrating and describing the Watertown steam engines.

Illinois Malleable Iron Co., Chicago, Ill., U. S. A.=Steam Catalogue, 1895, 372 pp., illustrating and describing an extensive and complete line of malleable and cast iron fittings for water, steam and gas, and steam fitters, engineers, natural gas, and water-works' supplies, engine trimmings, general mill and shop supplies and tools for steam fitters, gas fitters, machinists, etc.

Kalamazoo Radiator Co., Chicago, Ill., U. S. A.=Catalogue and price list, 13 pp., illustrating and describing the "Kalamazoo steam and water radiators.

American Industrial Publication Co., Bridgeport, Conn., U. S. A.=Catalogue of publications relating to science, civil, mechanical and electrical engineering, arts, trades, and manufactures.

The Buckeye Malleable Iron and Coupler Co., Columbus, Ohio, U. S. A.=Pamphlet illustrating and describing the "Little Giant Buckeye Coupler" for freight, passenger, and tender equipment.

The Adams Co , Dubuque, Iowa, U. S. A.=Illustrated catalogue of Farwell's milling attachment for iron planers.

J. H. McEwen Manufacturing Co., New York.=Elegantly illustrated catalogue of engines and dynamo-electric machinery, with diagram of efficiency.

John Stark, Waltham, Mass., U. S. A.=Illustrated descriptive catalogue of bench lathes, and an extensive line of watch-makers, lathes and tools.

Oneida Manufacturing Chuck Co., Oneida, N. Y., U. S. A.=Illustrated catalogue of lathe and drill chucks.

University of Nebraska, Lincoln, Neb., U. S. A =Announcement of the School of Mechanic Arts.

American Boiler Co., New York-Chicago.=Handbook of useful information, price lists, etc.

Newton Machine Tool Works, Philadelphia, Pa.=Illustrated catalogue of new boring, drilling, and milling machines.

The National Chuck Co., New York.=Catalogue illustrating and describing "National" lathe chucks, "Errington" tapping attachments, etc.

The Philadelphia Steel Roofing Co., Philadelphia, Pa.=Pamphlet illustrating and describing steel roofing, siding fire-proof lath, paints, cements, etc.

F. E. Reed Co., Worcester, Mass., U. S. A. =Illustrated catalogue of lathes and other machine tools.

Cleveland Twist Drill Co., Cleveland, Ohio, U. S. A.=Elegantly printed and illustrated catalogue and price lists of "Increase Twist" drills, self-feeding reamers, milling cutters' end-mills, arbors, etc.

John Platt & Co., New York.=Pamphlet illustrating and describing "Thornycroft" water-tube boilers.

Ford & Bacon, Engineers, New York-Philadelphia-New Orleans.=Large illustrated pamphlet entitled "Recent Engineering Work," reprinted from the *Street Railway Journal*, and describing the system of The Orleans Railroad Co.

Hilles and Jones Company, Wilmington, Del., U. S A.=Illustrations of new and special machine tools, and recent designs for working iron and steel plates, bars, and structural shapes.

The Hawley Down-Draft Furnace Co., Chicago, Ill., U. S. A.=Voluminous pamphlet, containing full exposition of the principles of the "Hawley" down-draft furnace, its applications to the prominent water-tube boilers now in use, and numerous illustrations, testimonials, etc.,

William E. Quimby, New York =Illustrated and elegantly printed pamphlet, describing the "Quimby Screw Pumps," the applications wherein their operation has been most satisfactory, etc.

We supply copies of these articles. See introductory.

IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Oil-Tube Drills.

THE engraving illustrates an improvement in drills recently brought out and now placed on the market by the Cleveland Twist Drill Company, Cleveland, Ohio.

In boring deep holes it is necessary that lubrication of the cutting and bearing surfaces shall be satisfactory. The close packing of the chips will not admit of proper lubrication by gravitation when holes are deep, and it is necessary to provide other means for forcing the oil down and onto the cutting lips.

In the improved "oil-tube drills" grooves are cut on each land part, just deep enough to admit of enclosing a small brass tube, making a smooth surface, as ordinarily provided for in twist drills. The tubes terminate at the lower ends in openings discharging the oil directly at the cutting edges of the drill. The upper ends of the tubes project from the shank of the drill, and through these the oil is inserted.

With a high speed and heavy feed drills heat at the point, as it is impossible to force in a lubricant, and it is to overcome this objectionable feature that these tube drills were devised. There may be several ways of conveying oil through the tubes; the most successful so far ascertained is as follows: The tubes are cut flush with the shank end, and a collet is placed on the shank which fits the turret. An oil pipe is connected with the center of the turret, and carried down to a chamber connecting with the butt end of the drill. The oil is forced through and onto the point with considerable force, and assists in sending the chips up the flutes, and at the same time keeps the cutting lips perfectly cool. Collets are made for various-sized drills, and, as the outside diameters of the collets fit the turret, a drill can be changed in a few seconds.

The Cleveland Twist Drill Company has already furnished a great many of these tools to turret lathe and bicycle manufacturers, which are said to be giving excellent satisfaction.

The Cummer Dryers—Stationary and Portable.

THE Cummer Dryer was first placed upon the market about nine years ago. Since these installations were made, The F. D Cummer & Son Co., of Cleveland, Ohio, has steadily improved this type of dryer, called style "A," and has placed upon the market a variety of other styles of dryers, so that now they manufacture eight different styles of revolving dryers, besides tunnel and portable dryers, and each style of dryer in a variety of sizes.

The company has dryers in operation in nearly every civilized country in the world, drying a great many different materials, and it is therefore prepared to handle successfully nearly everything that needs drying. These dryers of different styles are equally well adapted for drying coarse and heavy substances, clay, marl, phosphates, sand, etc., etc., but also for dealing with very delicate substances, and one style is much used by commission men and owners of grain elevators for drying damaged cargoes.

Heat resulting from perfect combustion mixed with large volumes of pure air is the drying medium. The purity of the heated air made in this way, and the absolute control which the operator has over the temperatures, are wonderful. The most delicate of materials are being dried in the style "F" with a variety of kinds of fuel, most satisfactory results being obtained.

Each style of revolving dryer consists of a revolving cylinder, the diameter and length of which depend upon the work to be done. The internal arrangement of the cylinder varies in the different styles of dryers, and so does the method of tempering the products of combustion and applying the same to the material to be

dried. The dryers revolve in brick work, and all bearings are so arranged that they are entirely protected from grit. The dryers cannot be injured by heat, or by expansion or contraction.

All work is done mechanically, even to the feeding of coal to the furnace; and, as nearly all of the heat units contained in the fuel are utilized, this system of drying is far in advance of any other in which only the radiant heat or the heat from steam is passed into the material, in which there is necessarily a very large waste, and in which, from its nature, the process is very slow.

For rapid and inexpensive drying, plenty of heat cheaply made with large volumes of air are necessary. These conditions the Cummer dryers supply; and the heated air can be mingled with material at any temperature desired, so permitting the operator to crowd the drying as much as the nature of the material will allow.

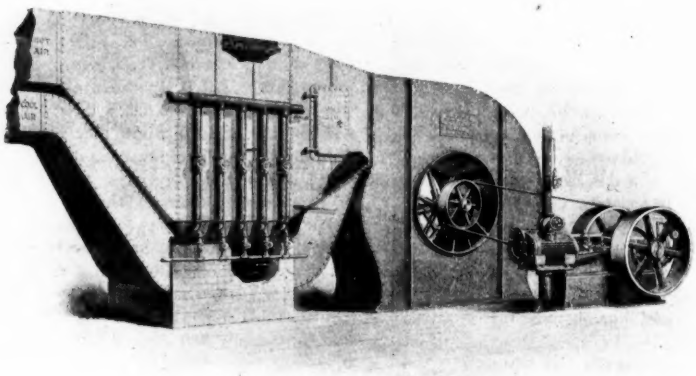
This company placed upon the market, about three years ago, an entirely new system of tunnel dryer for drying brick and other clay products, pulp, peat, moss, cement briquettes, etc., and, the number now in operation in different parts of the world and the testimonials received prove that this system has met with the same warranted and well-earned success as the Cummer revolving dryers.

This company's wide and varied experience enables it to accurately state the quantity of fuel required to do a given amount of work, and estimate closely the cost per ton of dried material.

A High School Heating and Ventilating Apparatus.

THE engraving illustrates a typical heating and ventilating apparatus for high, grammar and technical schools, widely used by the Buffalo Forge Co., Buffalo, N. Y., in its installations. The system has been introduced in a large number of such buildings with most excellent results. Mr. Schuyler Merritt, President of the Yale & Towne Mfg. Co., also President of the Stamford School Board, Stamford, Conn., writes to the contractors for the heating and ventilating plant in the High School, Messrs. Begent & Lynch, as follows:—

"It gives me pleasure to say that the heating and ventilating apparatus installed by you in the Stamford High School has proven to be entirely satisfactory. There has been no difficulty in keeping the school warm and the air has at all times been fresh. I say this with more confidence, because the principal of the school is quite particular on this point, and I should certainly have had it called to my attention if the contrary had been the case, so that experience confirms my own observation. I may add that the workmanship appears to be first-class; that your work was done promptly and in accordance with the specifications, and finally that I have entire confidence in your firm, both as business men and heating engineers."



A HIGH SCHOOL HEATING AND VENTILATING APPARATUS.

The apparatus consists of a 90" Buffalo steel plate pulley fan, full housing, an 8×8 Buffalo automatic center-crank horizontal engine, Buffalo

Forge Co.'s fan system heater, equal in capacity to 3700 sq. ft. of direct radiation, heating being supplied in four separate sections with individual steam connections to each, four rows of pipe in each section.

The engraving shows the construction, form and arrangement of apparatus where the double or duplex system of ducts are employed, supplying hot and cool air to each room. A swinging damper placed at the fan outlet, divides the currents at this point, directing the unheated air underneath the heater to the cool air ducts, while the air to be heated passes directly over the coils which are connected with the main hot air duct which leads to the various flues from which the air rises to the different rooms in the building. The hot air registers are located about 8′ above the floor line with the vents near the floor. In the double duct system, a mixing damper is placed at the base of flue, and its valve is controlled from the room said flue supplies by means of a chain which is attached to an indicator dial. The amount of ventilation is never diminished, and when the room is over-heated, the damper is fixed to admit more cold air, and vice versa. All air currents are delivered into the room at low velocity, and are imperceptible to the occupants. The same type of apparatus is also used where the temperature of the rooms is controlled by thermostats.

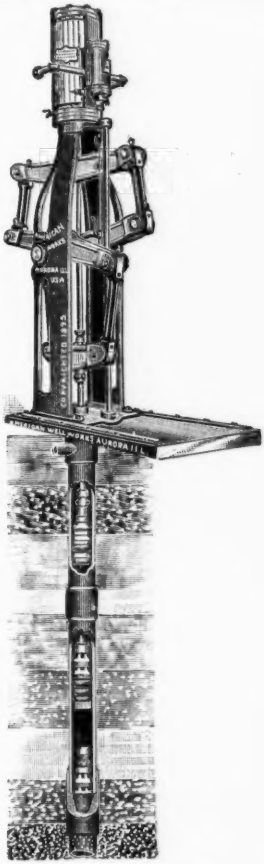
The Buffalo fan system is also employed in many other New England schools with uniform excellent results. The usual New England requirement in the way of air delivery is 30 cu. ft. of air per minute per pupil, but most of the Buffalo Forge Co.'s installations provide an amount in excess of this.

Up-to-date Method for Obtaining Increased Quantities of Water from Small-Sized Artesian or Tubular Wells.

THE accompanying engraving is from a photograph of an improved two-stroke vertical steam pumping engine, and water cylinder, manufactured by the American Well Works, of Aurora, Ill. (branch houses at Chicago, Ill., and Dallas, Tex.) This machine can be made in any size required for doubling the output of water from deep or shallow artesian wells, and it can be used with economy by cities, villages, or corporations, requiring additional service, without a corresponding increase in operating expenses.

The operation is as follows:

The brass water cylinder is suspended under the water surface inside of the pipe casing the hole, and is sustained by an independent line of pipe from the surface. This cylinder contains two plunger valves. The upper valve is operated by a hollow galvanized iron rod, with left hand coupling which works through the hollow plunger rod operating the upper plunger, and is attached to the upper cross-head of the engine. These rods are balanced, and cannot unscrew in the well. Thus the engine is relieved of the load of rods, and is enabled to do additional service. In operation one of the plungers is continually on the up-stroke, and, as with two plungers the number of strokes can be doubled, it necessarily

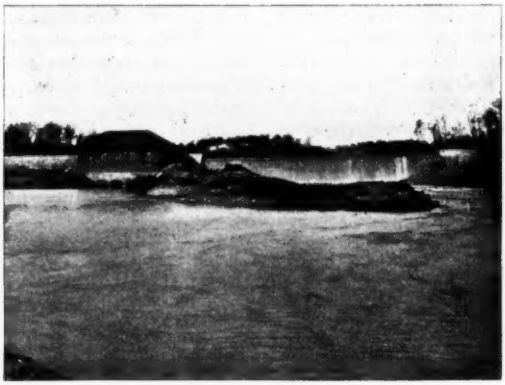


follows that twice the quantity of water can be raised.

This company also builds and installs steam or belted air compressor pumping plants, and makes estimates for interested parties on any of the various styles of pumping plants manufactured by it.

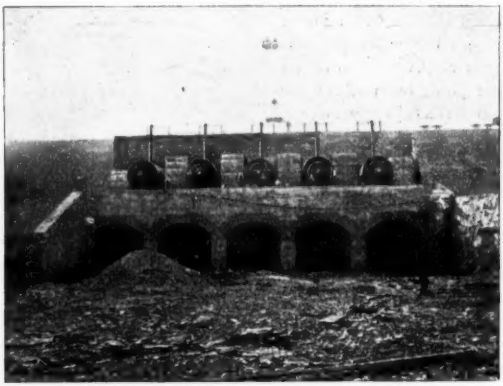
Power Plant of The Pelzer Manufacturing Company.

THE two half-tone engravings herewith illustrate the power plant recently installed for The Pelzer Mfg. Co., Pelzer, S. C. One engraving shows the dam and power-house, the other an interior view showing five pairs of 39" horizontal Victor turbines in position, each pair of which is coupled direct to a 1,000 h. p. generator and regulated by a Giesler electro-mechanical governor. The power thus generated is transmitted electrically to the cotton mills of the corporation, about 3½ miles distant. This is putting 5,000 h. p. into a very narrow space, and the arrangement permits locating the factories at a most eligible site. The dam and power-house were built by W. A. Chapman & Co., Providence, R. I. The electrical machinery was furnished by The General Electric Co. of New York, and the turbines, feeders, power connections, and electro-mechanical governors, together with all the plans for the entire development, were furnished by The Stilwell-Bierce & Smith-Vaile Co., Dayton, Ohio.



POWER PLANT. PELZER MANUFACTURING CO.

The installation is in every way creditable, and notable as an example of advantages of location rendered available through the aid of electrical transmission of power. The time has arrived when the location of factories no longer depends upon the location of water power.



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